Abacus Educational Game for Primary School Children: Fun with Abacus

By

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17900

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Technology (Hons)
(Business Information System)

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CERTIFICATION OF APPROVAL

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Approved by,

_____

(AP Dr Wan Fatimah Wan Ahmad)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
May 2015

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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(LEE JIA SHYAN)

ABSTRACT

Abacus is an ancient mathematical instrument used for calculation. Abacus is widely used in China, Japan and Russia. With the advancement of technology, the learning of abacus has been improved from time to time, from the traditional method, to the use of computer application such as courseware, website and the latest technology is mobile application in smart phones and tablets. Abacus calculating tool is compulsory to learn by all the level one primary school students in Malaysia. However, Abacus is boring to learn as it consists of repetition practices and endless exercises. Furthermore, Abacus education in Malaysia is still using the traditional ways which required students to memorize the calculation method. Moreover, the abacus mobile game available currently in Google Play Store which targets the children only consists of addition and subtraction whereas the syllabus of abacus in the education covers addition, subtraction, multiplication as well as division. To address these problem, the aim of this project is to develop a mobile game application on abacus for all the syllabus from addition until division. The application will focus on addition, subtraction, multiplication and division up to three digits number. Besides, the objective of this project is also to identify the learning styles of children and curriculum of abacus suitable for the primary school students. In addition, the author evaluated the user acceptance on the developed mobile application at the last phase of the project development. The method used to achieve the objectives is prototyping-based methodology. The mobile game is developed using App Inventor on the Android platform. The phase of requirement gathering was done through questionnaire survey, research and literature review study on information about abacus, advantages of abacus, learning approaches and the suitable development platform for the mobile game.

ACKNOWLEDGEMENT

This project would not have been possible without the support of many people. First and foremost, with this chance, I would like to say thank you to my supervisor, Dr Wan Fatimah Wan Ahmad and co-supervisor, Dr Hairuzila Binti Idrus. Without their guidance, I would not be able to complete this project.

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CHAPTER 1
INTRODUCTION

1.1 Background

Abacus is an ancient mathematical instrument used for calculation and the word Abacus is originated from the Greek words ‘abax’ or ‘abakon‘ (Young, 2004). It can be used to perform calculation such as addition, subtraction, multiplication as well as division. As early as AD 1200, abacus has been utilized to do precise calculation by the people (Frank & Barner, 2011).

There are many different types of abacus being used. These various kinds of abacus originated from different countries with different name. The three major types of abacus are the Japanese, Chinese and Russian abacus (Lutjens, 2012; UCMAS, 2007). According to Lutjens (2012) Japanese abacus also known as Soroban and Soroban is further separate into two types, 5+1 beads on each rod as shown in FIGURE 1.1 and 4+1 beads as shown in FIGURE 1.2 (Lutjens, 2012).

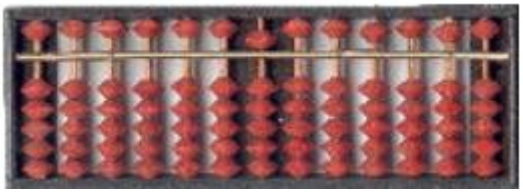

FIGURE 1.1: Soroban With (5+1) Beads

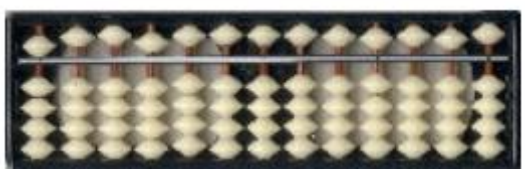

FIGURE 1.2: Soroban With (4+1) Beads

Whereas Chinese abacus is known as Suanpan and Russian abacus is called Stschoty as shown in FIGURE 1.3 and FIGURE 1.4 respectively (Lutjens, 2012).

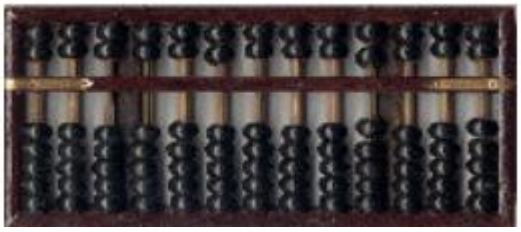

FIGURE 1.3: Chinese Abacus - Suanpan

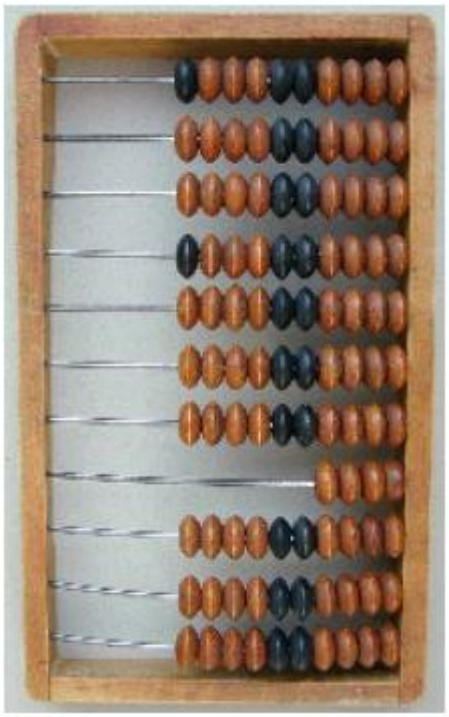

FIGURE 1.4: Russian Abacus - Stschoty

There are some similarities between the Chinese and Japanese abacus where both of them are divided into two levels with the beads on the upper level called ‘heavenly’ beads and the lower level called ‘earthly’ beads (Frank & Barner, 2011). Both the number of the beads for Soroban and Suanpan are different as shown in FIGURE 1.1, FIGURE 1.2 and FIGURE 1.3.

In 1994, Abacus had been introduced for the first time in Malaysia education (Mustama, 2010). In the early stage, type of abacus used was 5+2 which is the Suanpan

as shown in FIGURE 1.3. Malaysia called that type of abacus as 'Sempoa' in Malay language (Mustama, 2010). However, over the time, people found out that 5+2 type of abacus is not so effective to be used as a calculating tool therefore in 1996, the Education Ministry agreed to change the abacus to 4+1 type as shown in FIGURE 1.2 above and at the same time, mental arithmetic is also being introduced by the education ministry (Mustama, 2010). Although training of abacus teachers was conducted, but from 1996 until 2010, abacus education did not enforce formally in the schools (Mahat, 2004). In 2004, education ministry came up with a formal circular stating that abacus education is compulsory for the primary school students at level 1 which means the students from standard one to three (Mahat, 2004). Please refer to APPENDIX 1, 2 and 3 for the circular issued by the ministry of education.

According to Malaysia former Prime Minister, Tun Dr Mahatir Mohamad's official blog, he gives a positive review on abacus and believes that abacus can train the children brain to do fast calculation and this skill will contribute much to the skills in business (Mohamad, 2010). He also strongly supports the teaching of abacus in Malaysia primary school. It has also proven that learning abacus starts from young age as early as 6 to 7 years old, can improve the children's math skills and brain development (UCMAS, 2007).

Nowadays, there is abundance of educational apps about abacus in the form of mobile applications available to the public. Some of these mobile apps might be freely available for use such as 'Know Abacus', 'Abacus Math Game' and so on, please refer to the FIGURE 2.6 or may need to be purchased such as 'Mr. Abacus', 'Soft Abacus' and many more as shown in FIGURE 2.7 which are available in the Google Play store. No matter in what form they are made available, free or paid, the aim of any educational games is to teach something to the learners, so that the learners can learn better and acquire the proper knowledge.

However, majority of the abacus apps are in the form of courseware which is too difficult for the primary school children to use. Moreover, the abacus mobile games available currently in Play Store which targets the children consists mainly addition and subtraction only.

1.2 Problem Statement

Abacus education is made compulsory to primary school's level one students in Malaysia starting from 2004 (Mahat, 2004). The six main objectives of implementing abacus in Malaysian education system are to enhance the concentration, memorization, visualization, observation, rapidness and reading skills of the students (Mustama, 2010). However, some children have difficulty in learning abacus mainly due to several problems as stated below:

1.2.1 Abacus is Boring

Abacus is boring to learn as it consists of repetition practices and endless exercises. According to Agilemaths (2010), learning abacus is boring as it involves plenty of calculation which requires the students to be persistent, consistent as well as patient to practice daily. The reason that required students to have constant practice is that if the students stop utilizing their brain for calculation, their brain function will begin to decline slowly (Agilemaths, 2010). According to Mind (2013), as the level of abacus becomes higher, its complexity also increases and thus, children need more time to practice. Regular practices are necessary for the children to cope with the increasing difficulty of abacus. Hence, abacus becomes boring due to the same monotonous way of exercising problems (Mind, 2013).

1.2.2 Traditional Way of Learning Abacus

Abacus education in Malaysia is still using the traditional ways which required students to memorize the calculation method. The traditional method is not an effective method to learn abacus as the method is lack of cognitive interaction (Gee, 2014). Based on a statement made by a specialist in the study of memory, Edward Bolles, he stated that "We remember what we understand; we understand only what we pay attention to; we pay attention to what we want." (Keeley, 2011, p.9). The statement simply implies that memorizing is not the most effective method of learning but fully understand information at all cognitive levels is more crucial in learning.

1.2.3 Limitation of Current Abacus Mobile Game

The abacus game available currently in Google Play Store which targets the children only consists of addition and subtraction whereas the syllabus of abacus in the education covers addition, subtraction, multiplication as well as division (Mustama,

2010). By conducting this project, an abacus mobile game that covers all the syllabus will be developed in order to fill in the market's gap.

1.3 Objectives

The main objective of this project is to develop an abacus mobile game on Android operating system that will solve the problems as mentioned above. In order to achieve this, studies on children's learning styles and abacus syllabus should be done and after the development of the mobile game, user acceptance test should be conducted to identify whether the application meets the users requirements.

Therefore, in conclusion, the project's objectives are:

1. To identify the learning styles of children and curriculum of abacus suitable for the primary school students.
2. To develop an abacus mobile game on Android operating system.
3. To conduct user acceptance testing.

1.4 Scope of Study

The scope of the project is mainly to create an alternative way for the children to learn abacus through the mobile game. The project studies about the learning styles of different individuals and what is the most effective ways to let them learn based on their learning styles.

Project also consists of the best curriculum or syllabus that can be adopted by the mobile game to let the children learn abacus faster in a fun way. It comprises of addition, subtraction, multiplication and division up to three digits numbers.

Next, the project is to develop a mobile game of abacus for the children using the Android platform. The application requirements are based on the learning styles of children and proven abacus' curriculum. Target users for this mobile apps are:

- Primary students age 7 to 12 years old
- Beginners and learners of abacus

After the development of the application, user acceptance test will be conducted to find out the defects and the possible improvements that can be made on the application.

The application will be corrected based on the feedbacks from user acceptance testing until an application that fulfilled the needs of the users is developed.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

2.1.1 What is Abacus?

Greek words ‘abax’ or ‘abakon’ with the meaning table or tablet are the origin of the word ‘Abacus’ (Schools, 2007; Young, 2004). According to Young (2004), abacus is a mathematical device or tool used by the people for performing addition, subtraction, multiplication and division.

Far before the invention of modern computers, abacus has been widely used especially by the Chinese people for calculation purposes. The very first abacus was invented around 500 B.C.(UCMAS, 2007). However the modern abacus that we know today was the one been used in China started around 1300 A.D.(UCMAS, 2007).

According to Young (2004), there are three main forms of abacus that we are still continue using today, mainly the Chinese, the Japanese and the Russian abacus. Different countries named their abacus differently. They have similarity where all of the abacus are composed with rectangular frame together with beads on vertical wires or sticks. Nevertheless, the number of wires or sticks as well as the beads on the abacus are non-identical. The FIGURE 2.1 below illustrated the different types of the Chinese, Japanese and Russian abacus (Schools, 2007).

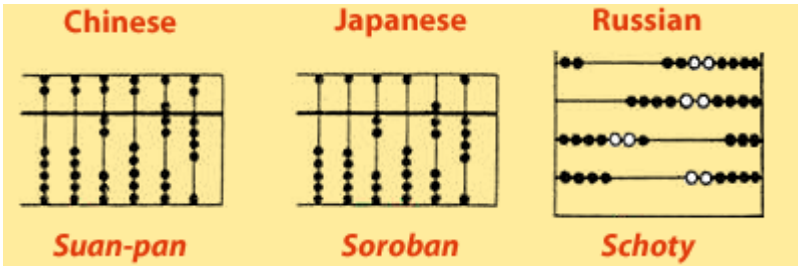

FIGURE 2.1: Types of Abacus

The abacus in this project is the Japanese abacus with one bead on top and four beads below. This type of modern abacus is now used in all the primary schools to teach the children in learning mathematics. Staring from 2004, educational ministry of Malaysia has come out with the circular to make abacus and mental arithmetic education compulsory in all primary schools for the phase one students which mean applicable for the students from standard 1 until 3 (Mahat, 2004).

2.2 Benefits of Learning Abacus

With the rapid growing of technology, most of the children nowadays depending too much on the calculators to solve mathematical problems. When they rely too much on electronic calculator, they are ignoring the opportunity to solve the mathematical problems mentally or using mental calculator (Assam Education & Management Academy (AEMA), n.d.). As a result, this will stop the brain of the children to be sharpen.

Why it is so? Similar with other organ of human body, human brain needs regular exercise to keep it fit and sharp. According to Assam Education & Management Academy (n.d), abacus is a good medium to exercise the brain. The primary benefit of it is that the children will have greater ability in calculating (Vasuki, 2013). Next, learning abacus will help the children to develop visualization skills (Vasuki, 2013). Basic mathematical operations like addition, subtraction, multiplication and division required just several simple movement of beads using abacus. This indirectly helps the children to develop representation of the problem in their brain and by regular practice, the children will develop photographic memory on their brain (Ahamed, 1999). This visualization skill will leave strong impressions on the brain cells for visual memory (Ahamed, 1999).

In addition, learning abacus will enhance the concentration of the children as abacus training required the children to be focused on the number and perform the calculation fast and precisely (Ahamed, 1999). Children with higher concentration generally achieve higher academic performance in school (Assam Education & Management Academy (AEMA), n.d.).

Moreover, learning abacus promotes patience and observatory skills as well (Vasuki, 2013). It is because abacus is made of small beads and through constant use of the abacus, a sense of patience and alertness is formed (Vasuki, 2013).

2.3 Learning Approach

2.3.1 Learning Styles

There are various learning styles that suite for different people. Same goes to the children. Not a single way of learning approach is suitable for all the children. According to B. Scheiber (1987), there are three dimensions of learning styles which are visual, auditory and kinesthetic. According to Online (2013), 65% of students are visual learners, 30% of the population are auditory learners whereas 5% of the rest are kinesthetic.

A visual oriented student will learn better using pictures or visualization. Visual learners usually have strong sense toward the colours (B. Scheiber, 1987). According to Elisabeth (2014), visual learners prefer the information to be presented in the written form or in the mind-maps, charts or diagrams. Visual learners fond to use colour code in making their notes (B. Scheiber, 1987). Nevertheless, visual learners usually have difficulty with spoken directions (B. Scheiber, 1987). They like to make use of graphics such as slides, illustrations and diagram to reinforce their studies (Schools, 2007). According to Indian abacus research, visualization is the key to better understanding. Hence, the abacus calculation through visualization using mobile game will make the children to have a full concentration (Basheer, 2012).

On the other hand, auditory learner prefers hearing to understand the contents (Basheer, 2012). In the classroom, teachers teach verbally. Hence, auditory learners learn better in classroom (B. Scheiber, 1987). In general, auditory learners enquire information via listening and they mostly have difficulty following written directions

(Elisabeth, 2014). The best method that drives them to learn is through discussions and read out loud (B. Scheiber, 1987).

The third one is kinesthetic learner who are the smallest group in the population (Elisabeth, 2014). They learn something via experiment or hands on activity (Online, 2013). The strength of kinesthetic learners is that they can assemble parts without reading any manuals or directions (B. Scheiber, 1987). However, they have problem sitting still (Online, 2013). The best method for them to learn easily is via experimental learning like lab work, role playing and many more (B. Scheiber, 1987). The disadvantage is that they require frequent breaks in between their study periods. Nowadays, with the advancement of technology, they can strengthen their learning process via sense of touch using computer software or mobile application (Online, 2013).

In short, the best solution to gain interest of learning from majority of the children is to combine these three learning styles. The FIGURE 2.2 below shows the summary for the 3 learning styles (B. Scheiber, 1987).

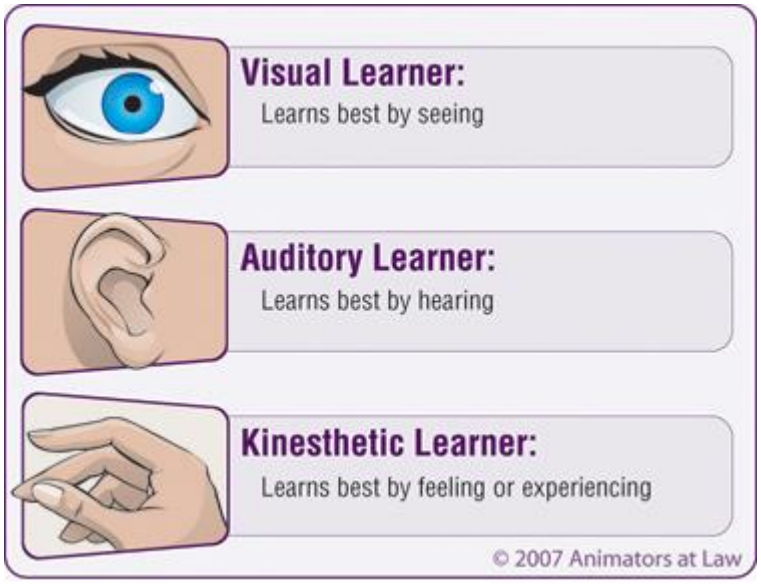

FIGURE 2.2: Summary of the 3 Learning Styles

2.3.2 Constructive Learning Theory

Constructive learning theory which is also widely known as constructivism indicates that the learners construct or build knowledge by themselves (B. Scheiber, 1987).

According to Hein (1991), constructive learning theory emphasizes on the importance of the active involvement where learners use their current or past knowledge to construct new ideas or concepts.

Yimin (2003) claimed that learning environment is one of key factors that greatly influence the learning process. Constructivism environment should be set up in school where real world situations are discussed and the students are encouraged to engage in an active dialogue with each other (Yimin, 2003). However, most of the time in the traditional classroom, students spend their time jotting down the notes rather than digesting or trying to understand on the information delivered (Yimin, 2003).

Relating to the scope of this project, constructivism in mathematics is an essential learning method for students (Leidner & Fuller, 1997). Based on the study of Muddin (2013), there was a research from Schwingendorf which claimed that students need to construct their own understanding of each mathematical concept as the purpose of teaching is not to lecture, explain, or just trying to "transfer" mathematical knowledge, but is to create situations or environment to foster students in making necessary mental constructions. Furthermore, constructivism enable the breakdown of each mathematical concept into developmental steps (Muddin, 2013).

According to Muddin (2013), adults always influence the way the children doing mathematics using their own way, this action will affect greatly on the learning effectiveness of the children. Instead of asking the children to solve mathematical questions based on the usual method, children should be encouraged to develop their own knowledge based on their own understanding (Hughes, 2003). These ideas can be converted and applied in the designation of the mobile application later which will benefit the children.

2.3.3 Learning through Play

Play is consider as an activity where the children always smile, laugh and enjoy (Hughes, 2003). Mobile game is considered as a modern play. According to the research done by Smith and Pellegrini (2008), children spend up to 30% of their time and energy in play. Hence, playing and learning should be combined together so that the learning process of the children is most enjoyable. The cognitive behaviour theory

revealed that when children feel happy in their learning, they tend to absorb the contents faster and understand the information easier (Smith & Pellegrini, 2008).

According to Sincero (2012), play in home is more effective than at school as there is less pressure. Study showed that learning via play at home is preferable by the students and the percentage of subject understanding is higher is the students learn through playing (Kennewell & Morgan, 2006).

2.4 Technology

2.4.1 Courseware

Courseware is usually used with a computer and it serves as an educational material or educational kits for teachers, trainers as well as the tutorials for students (Smith & Pellegrini, 2008). Courseware usually is delivered through CD-ROM. Many types of knowledge can be transferred using courseware but mostly the information technology knowledge is transferred using this method (Jing, 2005).

2.4.2 Web-based Learning

Web-based learning is also known as e-learning, online learning or distance learning, are usually used interchangeably (Jing, 2005). Web-based learning encompasses all educational interventions that pass through the internet or local intranet mediums (Tsai & Machado, 2003). Learning by using web enable the learners to access to up-to-date information as web-based learning requires internet usage and therefore contents can be updated easier compared to other learning methods.

FIGURE 2.3 shows an example of current web-based abacus game available in the market.

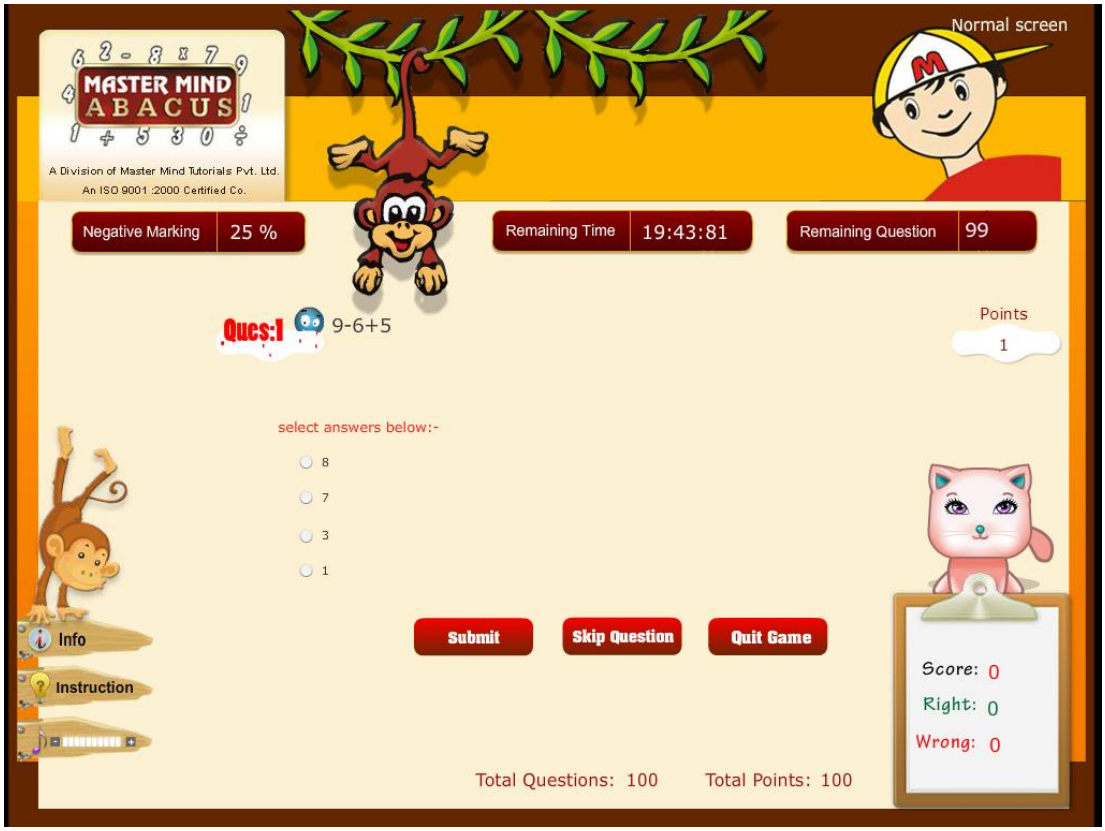

FIGURE 2.3: Snapshot of The Web-Based Abacus Game in The Current Market (source http://mmtplonline.com/abacus.php?pro=3)

2.4.3 Mobile Application

According to Cook (2007), mobile application is most frequently referred as an app. It is a kind of application software designed to run on a mobile device such as smart phones, tablets or any touch screen devices. Mobile applications commonly provide users with similar and simpler services to those accessed on computer. They are normally small, light with limited and isolated functionality such as game, calculator, mobile Web browsing and others located on various types of mobile software platforms.

2.4.4 Technology Trend

Parents always wonder of the effective way for the kids to learn. Over the years, many theories and techniques have been developed in order to provide the best learning method for the children. The method used in this project is M-learning.

M-learning stands for mobile learning which is an extension of e-learning where the focus is on the use of mobile application and wireless technology (Janssen, 2012). According to the digital learning report by Speak Up which is a workshop that the main objective is to encourage people to think innovatively, it claims that the use of mobile devices and mobile-enabled content in the classroom have the potential to significantly impact student achievement (Janssen, 2012; Mahamad, Ibrahim, & Taib, 2010).

Therefore, this project makes use of the mobile application or the M-learning to create a better abacus learning platform for the primary school children. Mobile game is a fun and interactive way to learn less interesting subjects. Furthermore, mobile game can attract the interest and attention of the children by using some animation and colourful interface.

2.5 Mobile Games

2.5.1 Overview

With the huge improvement of technology nowadays, the mode of playing games has changed to digital (Janssen, 2012). Digital gaming included computer games, mobile games, portable console games and many more. According to Paper (2009), the mobile gaming is emerging very fast and has becoming prominent segment of the digital gaming market. FIGURE 2.4 below shows the digital gaming growth among the five main type of digital gaming and the result proved that mobile gaming undergoes the most vigorous growth as compared to others (Paper, 2009).

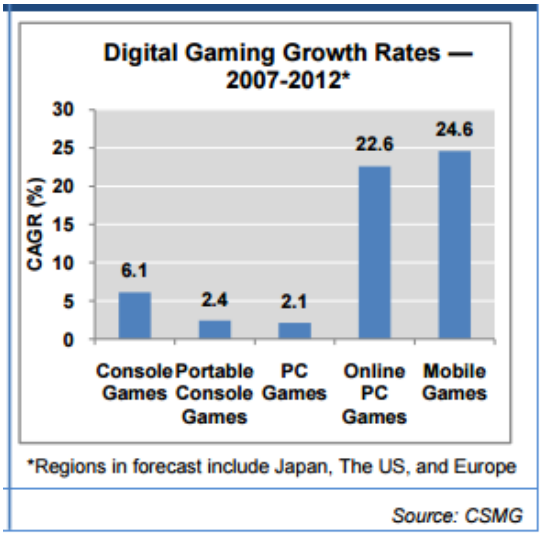

FIGURE 2.4: Digital Gaming Growth

With reference to the research of (Paper, 2009), people tends to play games to kill off the time and people favour mobile games more as compared to other digital gaming due to mobility of the mobile phone. In the past few years, the mobile gaming market has gained more and more popularity due to the cheaper price of mobile phone. FIGURE 2.5 below shows the growing of global mobile gaming market in term of US dollars (Fritsch, Ritter, & Schiller, 2006).

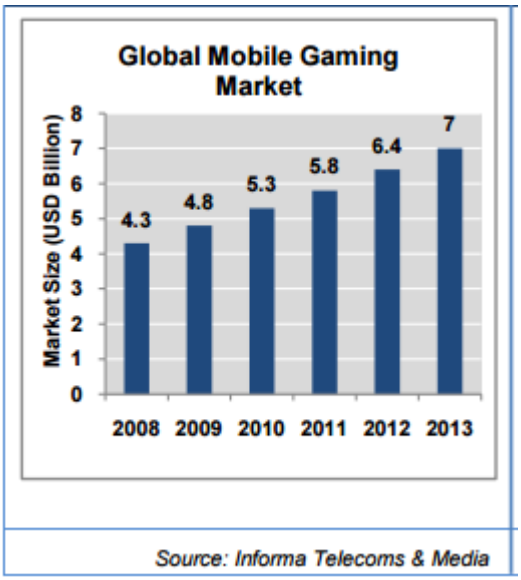

FIGURE 2.5: The Mobile Gaming Market

2.5.2 Games Genre

There are many types of games available in the market. In order to ease the users to choose what type of games they want to play, the mobile games are all categorized according to genre. According to Paper (2009), categorizing games into different genre means to define games in terms of their characteristics and common style. There are 16 common game genres in mobile games as claimed by (Hanna, 2014). TABLE 2.1 below shows the game genres with the example of famous games available in the current market based on each genre (Paper, 2009). The most popular game genre among the public based on research of Hanna (2014) is puzzle games. The abacus mobile games that this project is developing is categorized as educational games.

TABLE 2.1: Games Genres (adapted from Paper, 2009)

No.	Genres	Examples
1	Adventure games	Zork, King's Quest, Grim Fandango, Fahrenheit
2	Action games	Pong, Space Invaders
3	Action-adventure games	Legend of Zelda, Jak 3, Metroid Prime 2
4	Platform games/ Platformers	Pitfall, Super Mario Bros, Sonic the Hedgehog, Super Mario 64
5	Fighting games	Virtua Fighter, Tekken
6	Real-time strategy (RTS) games	Dune 2, Command and Conquer, Warcraft, Age of Empires
7	Turn-based strategy games	Civilization, X-COM, Master of Orion, Jagged Alliance
8	Role playing games (RPGs)	Final Fantasy, Baldur's Gate, Wasteland, Neverwinter Nights, Elder Scrolls Oblivion
9	Horror games	Alone in the Dark provides, Resident Evil
10	Simulation games	SimCity
11	Racing games	Pole Position, Mario Kart, Gran Turismo, Need for Speed, GTR
12	Sports games	John Madden Football , Tiger Woods' Golf , Pro Evolution Soccer, Championship Manager
13	Rhythm games (music games)	Dance Revolution, O2 Mania
14	Puzzle games	Tetris, Lemmings, Minesweeper, Boulder Dash
15	Traditional games	Chess, Checkers, Backgammon, Mah-Jongg, Go, Scrabble
16	Educational games	Carmen Sandiego series, Mavis Beacon Teaching Typing, Dr Kawashima's Brain Training, Abacus Math Games

2.5.3 Advantages

Mobile games are now being recognized as an effective tool to teach or further solidify concepts by many researchers as mobile games are more to active learning through cognitive interaction which the traditional schooling lacks of (Gee, 2014; Hanna, 2014). The main advantage of mobile educational game is that it enables the users to learn in non-classroom environment such as home and public areas (Kim et al., 2011). Besides, mobile games are interactive because mobile games enabled players to interact with the games environment and thus make the games more interesting and the players have the sense of engagement which will draw their attention (Miangah & Nezarat2, 2012). In addition, mobile phone is convenient to bring around and apart from mobility, mobile games help people to save money as people do no need to purchase an expensive console or computer in order to play the games (Paper, 2009;

Shameem, 2012). Mobility as mentioned above is the main reason why people play mobile games as compared to other digital gaming (Fritsch et al., 2006).

2.5.4 Disadvantages

The main disadvantages of mobile educational games are the distraction factors. When children play with the mobile phones, they will face the distraction with the incoming calls or messages. They also tend to play with casual and entertainment based games as compared to educational games when they play alone without the guidance of the parents (Fritsch et al., 2006).

2.6 Current Applications in the Market

When the word abacus is typed in the Google Play Store, hundreds of applications related to abacus will surface that come with different languages and also to serve different purposes. However, not all the abacus applications are created for educational purpose meant for children. Hence, it is difficult for the parents to choose the best application that can be used to teach the children on abacus. FIGURE 2.6 below shows the list of free abacus mobile applications available in Google Play Store and FIGURE 2.7 shows the paid abacus mobile applications available. According to Google Play Store, the paid abacus mobile applications' price ranged from RM3.50 to RM58.96.

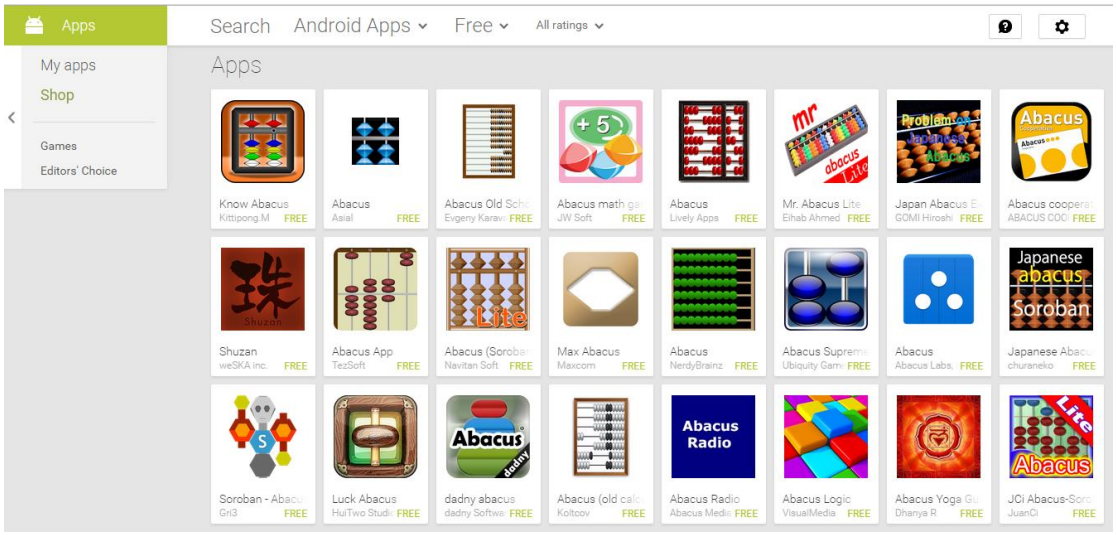

FIGURE 2.6: Free Abacus Apps in Google Play Store (source https://play.google.com/store/search?q=abacus&c=apps&price=1&hl=en)

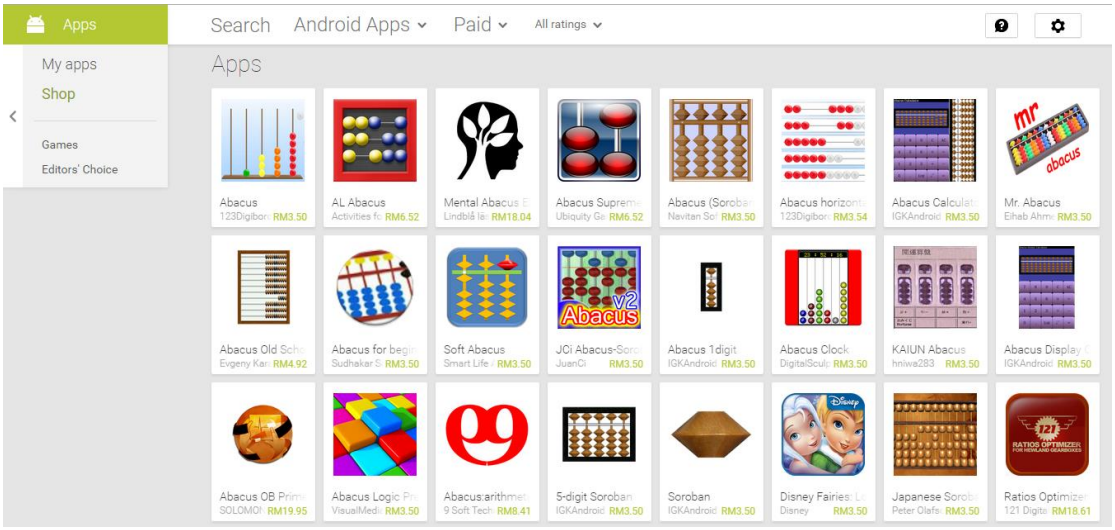

FIGURE 2.7: Paid Abacus Apps in Google Play Store (source https://play.google.com/store/search?q=abacus&c=apps&price=2&hl=en)

There are too many abacus apps available in the Play store. Nevertheless, three applications have been chosen as they are most related to this project. They are 'Know Abacus', 'Abacus Math Game' and 'Mr Abacus'. Below are the interfaces and brief explanations of those applications adapted from the Google Play Store and some snapshots of the applications.

The first application, Know Abacus is the most popular abacus apps in Google Play Store with 50,000-100,000 installs (Catapano, 2014). The apps creator claims that the application is suitable for children age five and above, who know about numbers and some basic addition and subtraction (Kittipong.M, 2014). However, the tutorial provided is in written format with a lots of words which is difficult for the primary school children to understand. It consists of repetition exercises in order to let the users master the abacus. FIGURE 2.8 and FIGURE 2.9 are the views of the application's interfaces. FIGURE 2.10 shows the reviews of the users. Majority of the users are adults and they found the applications useful. However, this application is not user friendly to the children as the tutorials are written in lengthy sentences which are difficult for the primary school children to understand. Hence, it can be said that this application is better or suitable for the adults as compared to children.

Figure 2.8: Landing Page of Know Abacus Application (source https://play.google.com/store/apps/details?id=com.lookkidsw.KnowAbacus)

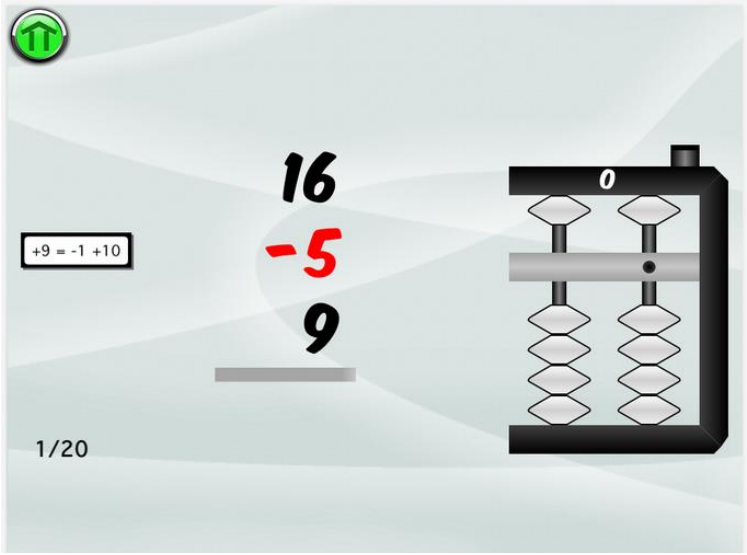

Figure 2.9: Example of Abacus Exercise of Know Abacus Application (source https://play.google.com/store/apps/details?id=com.lookkidsw.KnowAbacus)

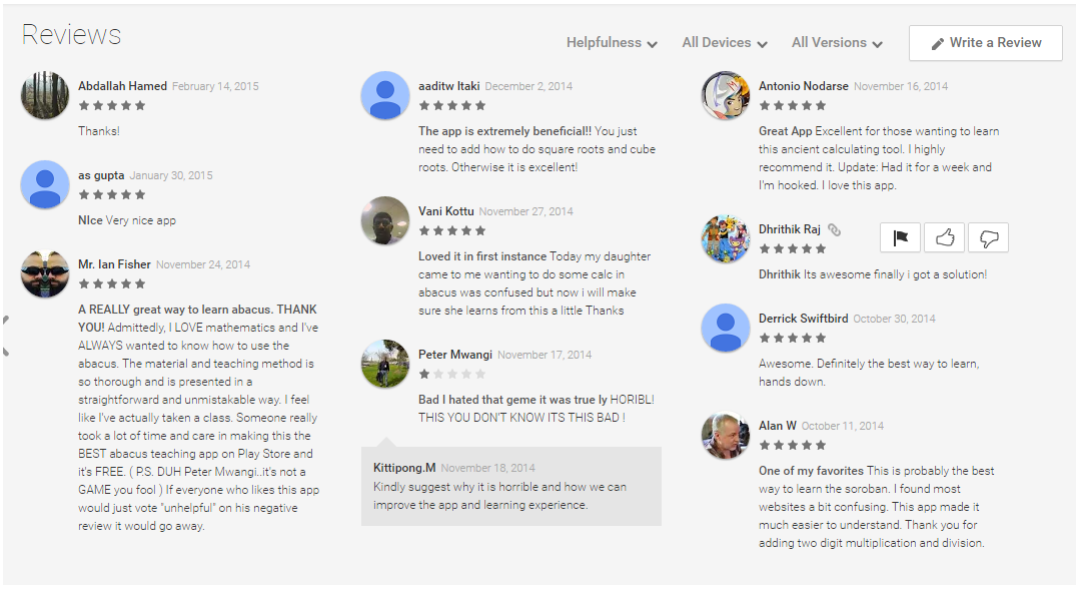

Figure 2.10: Reviews of Know Abacus (source https://play.google.com/store/apps/details?id=com.lookkidsw.KnowAbacus)

The second application, Abacus Math Game is an abacus game that comes with interesting and colourful interface. However, this application does not provide any tutorial for the beginners on how to play the abacus. It only consists of small hint on the first level. The following levels do not have any hints that can let the users know how to play the games. Furthermore, many users complained about the flickering issue of the application because of the bugs in the application as shown in FIGURE 2.12 below (Kittipong.M, 2014) whereas FIGURE 2.10 illustrates the application's interfaces.

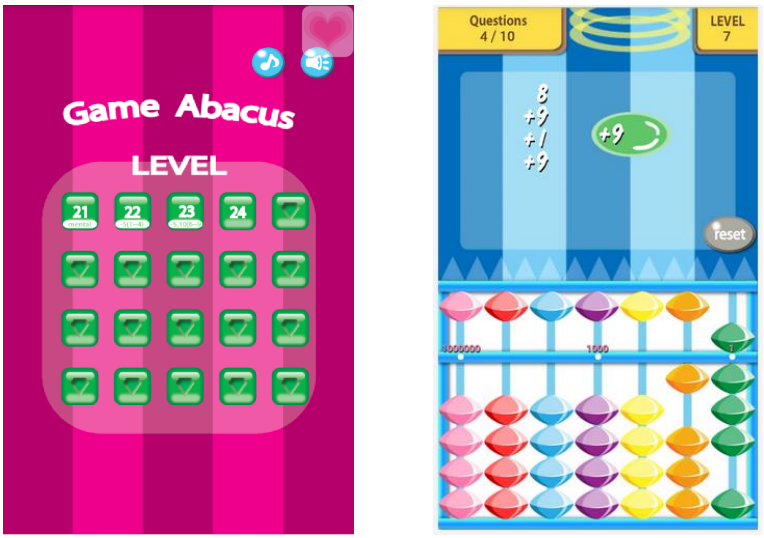

Figure 2.11: Landing Page and The Game Interface of Abacus Math Game (source https://play.google.com/store/apps/details?id=com.jwsoft.gameabacus)

Below are the snapshots of review for the Abacus Math Game applications available in the Google Play Store.

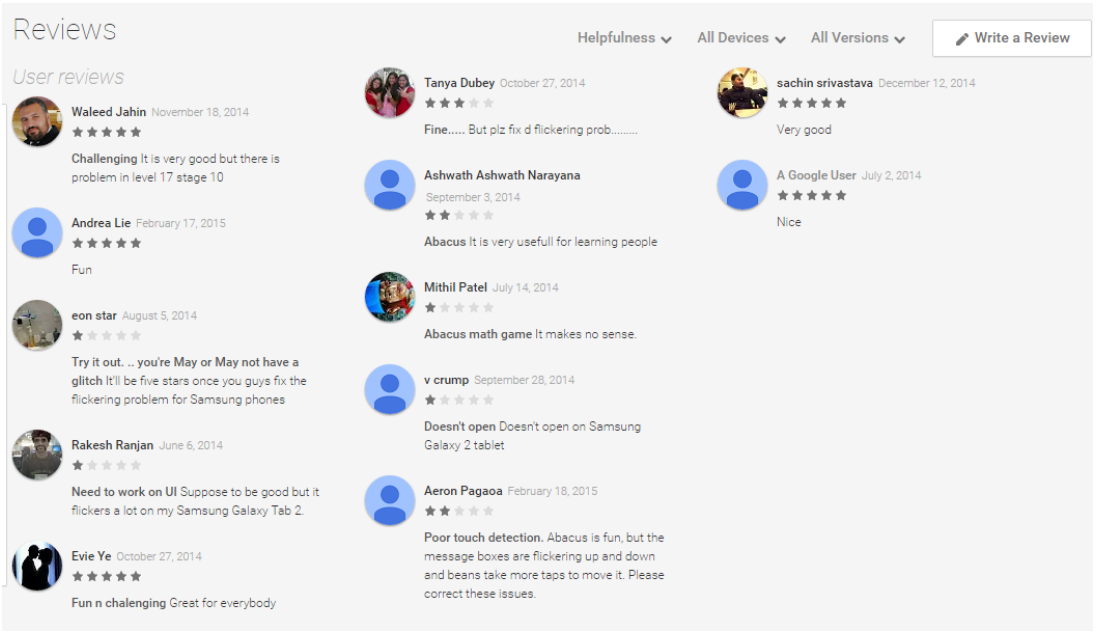

Figure 2.12: Reviews of Abacus Math Game (source https://play.google.com/store/apps/details?id=com.jwsoft.gameabacus)

The third application Mr Abacus is a paid application. Users need to pay RM3.50 in order to use the application (Nananqeen, 2014). This mobile game also does not provide any tutorials for the users and moreover, this application only has addition and subtraction of abacus. FIGURE 2.13 shows the interfaces of Mr Abacus.

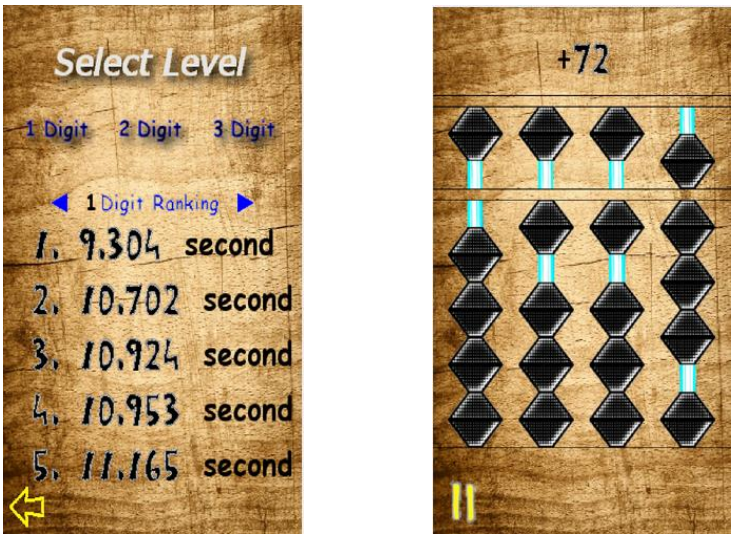

Figure 2.13: Landing Page and Game Interface of Mr Abacus (source https://play.google.com/store/apps/details?id=com.bbk.mrabacus)

Based on the information given in Google Play store and the observation as well as the experience of playing the three mobile applications stating above, the details of those applications are summarized in TABLE 2.2.

TABLE 2.2: Details of Abacus Applications Available in The Market (adapted from https://play.google.com/store)

Applications / **Descriptions**	**Know Abacus**	**Abacus Math Game**	**Mr. Abacus**
Application Focus	Focus on the users who want to learn abacus. Provide tutorial in written format and exercises for learning abacus.	A game for the users who know the basic of abacus. Solve the equation before the bubbles burst. Include mental abacus as well inside the game.	A game for the users who know the basic of abacus. The faster the users solve the calculation will consider win.
Learning method	Repetition practice	Game	Game
Tutorial	Tutorial in word form	No tutorial	No tutorial
Addition	Yes	Yes	Yes
Subtraction	Yes	Yes	Yes
Multiplication	Yes	No	No
Division	Yes	No	No
Free/Paid	Free	Free	Paid
Children Focus	No	Yes	No
OS	Android & IOS	Android	Android
Comment from users	Good for abacus beginner but boring tutorial	Flickering problem	No review

CHAPTER 3
METHODOLOGY

3.1 Research Methodology

Choosing the right methodology is very crucial in order to complete the project on time. The method that is adopted to develop the abacus mobile game is the prototyping-based methodology. Time is very critical in working on this project. Therefore, prototyping methodology which is one of the agile approaches and less time consuming will be used for this project.

Agile approaches also known widely as lightweight approaches (Ahmed, 2014). It is not only less time consuming as compared to the traditional method such as waterfall, but it also enhances the evolutionary of development as well as the delivery (Rahim, 2014).

The prototyping-based methodology is a systems development method where an early approximation of final product called the prototype is built, tested, and then reworked as necessary until an acceptable prototype is finally achieved from which the complete system or product can now be developed (Rahim, 2014). This model works best in scenarios where not all of the project requirements are known in detail ahead of time (Rouse, 2005).

The main advantage of using this methodology is that it allows changes to be made during the development phase by reviewing and redoing the prototype (Rouse, 2005). This is important as it provides the flexibility in developing and improving the

application. FIGURE 3.1 below shows the steps involved in the prototyping-based model based on (Sparrow, 2011).

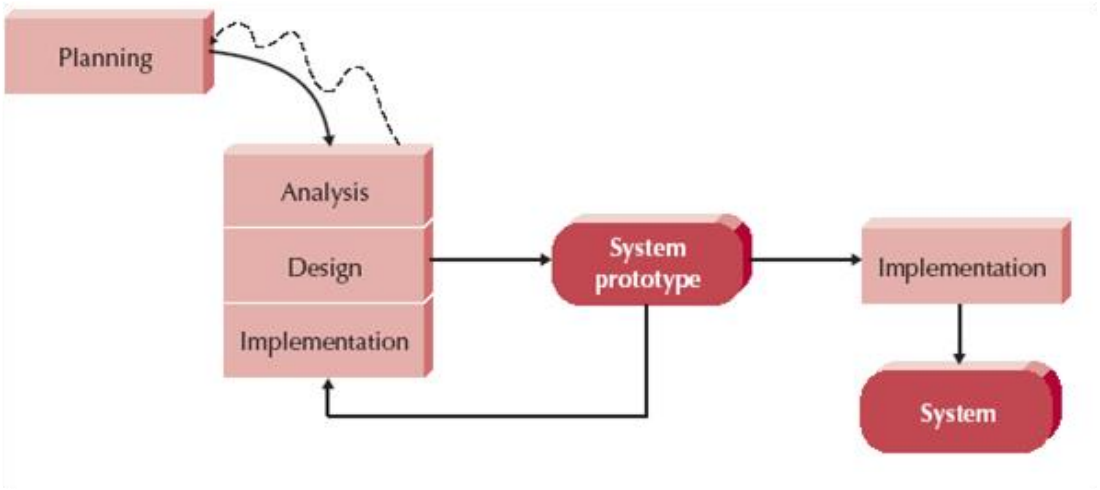

FIGURE 3.1: Prototyping-Based Methodology

Table 3.1 shows the separation of the phases in prototyping-based methodology across the two semester which is FYP I and FYP II in order to complete the whole project.

TABLE 3.1: Project Planning

FYP	Phases Covered
FYP I	➢ Planning ➢ Analysis ➢ Design
FYP II	➢ Design ➢ Testing ➢ Implementation

3.2 Project Activities

3.2.1 Planning

Planning is the first phase of the project. First, some related research was conducted by reading through research papers, journal papers, websites and books that are relevant to the topics of research. The areas of studies include understanding about the current problem relating abacus learning in school, ways to resolve those problems, the behaviour or learning approaches of primary school students, the syllabus of the abacus study and also mobile application development. In addition, information from the internet and Google Play Store was gathered to gauge on the existing mobile

applications in the current market that have already been developed and what are the improvements to be made on those applications.

3.2.2 Analysis

In the analysis phase, survey and questionnaires were used to obtain feedback concerning the opinion of primary school children and parents on learning abacus. The surveys were prepared in questionnaires format which consist of written set of questions where respondents can choose their answer and at the same time, write down their additional opinions on this project.

The author had conducted the survey with the students and guardians of the students at Pusat Perkembangan Minda Riang (MRC Learning Center), Super Education Group (Pasir Puteh Branch) and SJK (C) Chung San, Tronoh. Besides, the questionnaire for the parents also has been posted online to seek for more respond. There are total of 96 student respondents and 51 parent respondents after deducted the invalid or incomplete survey feedbacks received by the author. The responses from the surveys were analysed and the answers from the respondents were used expand knowledge about the project.

3.2.3 Design

During the design phase, works on the prototype began. The process started with the interface of the mobile application. The interface was designed using Photoshop and a virtual application design was developed using Prototype on Paper (POP). Next, basic architecture design of the application was developed. In this phase, the graphics, interface of the application, the input and output process of the application, functionalities of the system and the information that is needed by the application are determined. Next, using the information, a workable prototype is created using the tools such as MIT App Inventor and Android SDK.

Figure 3.2 shows the interface of the prototype created using the Prototype on Paper software (POP).

FIGURE 3.2: Prototype Created Using POP

3.2.4 Implementation

At this phase, the design of the prototype has been finalized and a real application is developed in the implementation phase. This phase will involve the building of the application in details specifications using required software which is the App Inventor and hardware. App Inventor is used in order to create the colourful and attractive interface of the mobile game. Since the project is using prototyping-based methodology, changes and improvements can still be made based on the result and feedback received from the user acceptance test. This process will be repeated until an acceptable product is developed.

3.2.5 Testing

Usability testing or the user acceptance test is conducted in this phase where the prototype built earlier will be tested by the primary school children as well as the teachers and parents. Their feedbacks and reactions during the testing are recorded to make improvement on the current prototype until the prototype meets the requirements of the users. The author has done the testing with 11 primary school students who attend Miss Chong Kar Yee home tuition. Each student is first given one question paper which consists of 10 addition questions to perform calculation manually, the time taken to complete the questions is recorded. After that, they will be given the mobile game to play and at the same time, their reaction is observed and jotted down by the author. Similarly, when they are playing the game, the time taken to complete ten questions is recorded. The testing result is computed and analysed in order to make improvement on the mobile game developed.

Besides, 14 parents and teachers have done the testing too. They are given the mobile game to play. After that, a questionnaire form is given to them to find out the opinion of the parents and teachers on this mobile game. The responses are used to make improvement on the mobile game as well.

3.3 Mobile Game Architecture

The mobile game architecture is as shown by FIGURE 3.3. The architecture is started with the user part which is the primary school children. They are the targeted end users who will be using this application for their learning process in abacus. There are three main functions in this application which are the Tutorial, Play and About. In Tutorial part, there are 5 more sub-parts which are Count, Addition, Subtraction, Multiplication and Division. Tutorial is the part where the children can learn how to use abacus step by step. Whereas at the Play section, there are 4 sub-sections such as Addition, Subtraction, Multiplication and Division. This part is where children can play the game in order to further master the abacus. The last section is the About section, this section simply explains about the application itself to the users. The further explanation on the architecture will be provided in Chapter 4 together with the screen shots of the application for a clearer view.

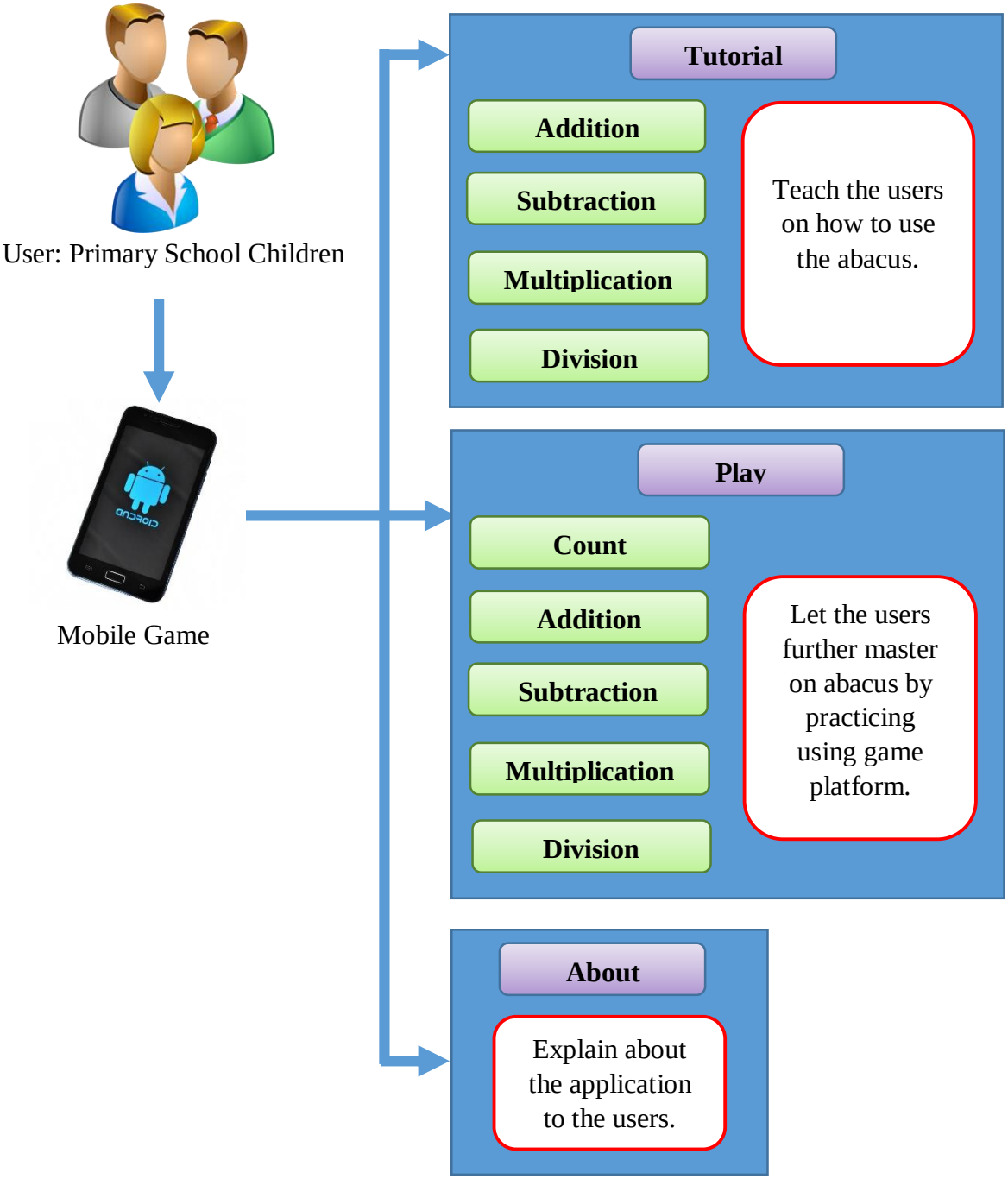

FIGURE 3.3: Mobile Game Architecture

3.3 Gantt Chart

TABLE 3.2: Gantt Chart of FYP1

	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Research & survey on project										
Interims Report										
Introduction										
Literature Review										
Methodology										
Result & Discussion										
Conclusion										
Prototype										
Design										
Development										
Presentation										

TABLE 3.3: Gantt Chart of FYP2

	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Project Work Continue												
Prototype												
Testing												
Technical Report												
Dissertation												
Pre-SEDEX												
VIVA												

3.4 Tools Required

3.4.1 Hardware

For this project, the hardware required have been identified and have been listed down below. A personal computer is needed to develop the mobile games and test the mobile games using mobile phone and tablet with Android operating system.

- Personal computer
- Mobile phone with Android operating system
- Tablet with Android operating system

3.4.2 Software

The software needed to build the abacus mobile game are as shown below. The interfaces of the abacus mobile game were drawn using Adobe Photoshop CS5. The prototype is built using Prototype on Paper (POP) mobile application due to time constraint and the real mobile game is developed using MIT App Inventor embedded with Android Software Development Kit (SDK).

- Adobe Photoshop CS5: For pictures editing
- Prototype on Paper (POP) mobile application: To develop the prototype
- MIT App Inventor: To develop the complete version of abacus mobile game
- Android Software Development Kit (SDK): Compatible with the App Inventor to develop the abacus mobile game and provide emulator to test the application.

CHAPTER 4
RESULT AND DISCUSSION

4.1 Survey Result and Feedback

4.1.1 Children

The survey was conducted using questionnaires format as shown in the APPENDIX 4. The respondents of this survey were the primary school students aged seven to twelve years old. The survey objective is to find out what is the opinion of primary school children on mathematics subject, abacus and mobile games. These forms have been distributed to the students at Pusat Perkembangan Minda Riang (MRC Learning Center), students at Super Education Group (Pasir Puteh Branch) and students at SJK (C) Chung San, Tronoh.

Total of 96 primary school students which consist of 44 females or 45.83% and 52 males or 54.17% had participated in this survey. About 21 or 21.88% of them are seven years old, 20 or 20.83% eight years old, 34 or 35.42% nine years old, 6 or 6.25% ten years old, 4 or 4.17% eleven years old and 11 or 11.46% twelve years old as shown in FIGURE 4.1 below.

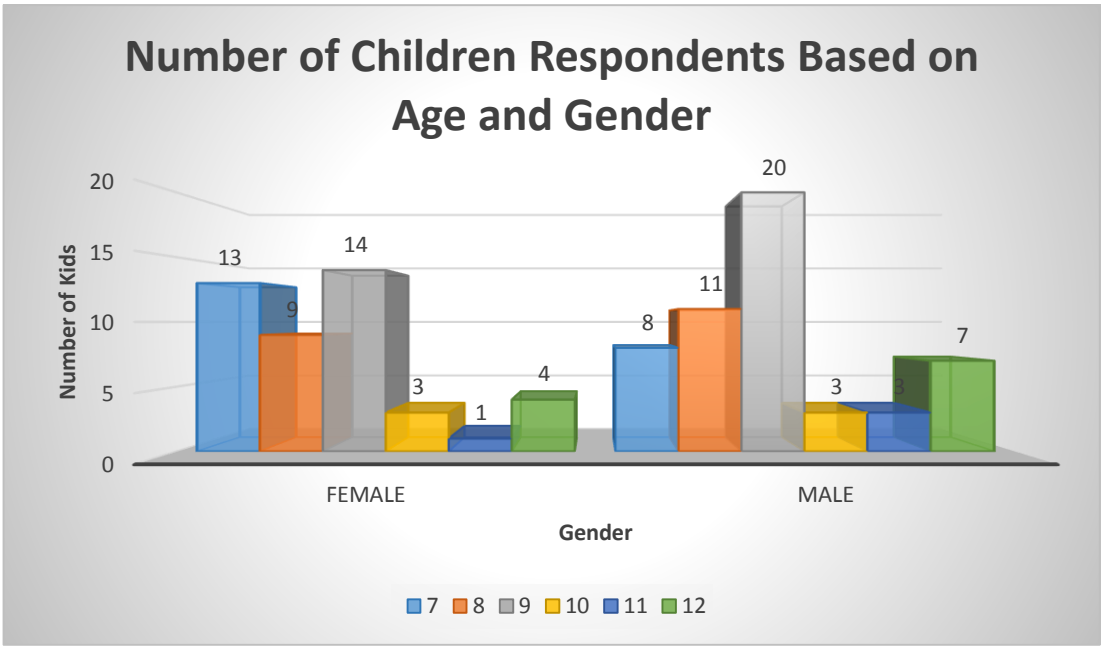

FIGURE 4.1: Number of Children Respondents Based on Age and Gender

Based on the questionnaires, the following results were found:

(i) Majority (82.30%) of the children claimed that their parents own an Android smart phone and up to 86.46% said that they have played games using the smart phone. Even though most of the children played mobile games before, only 53.13% play the educational games such as mathematics games, language games and so on. Most of the time the children play non-educational based game using the mobile phones.

(ii) From the survey, it was found out that majority of the students which consists of 55.23% play mobile games less than three times per week as shown in the FIGURE 4.2 below. It is mainly because their parents do not allow them to play mobile games too often.

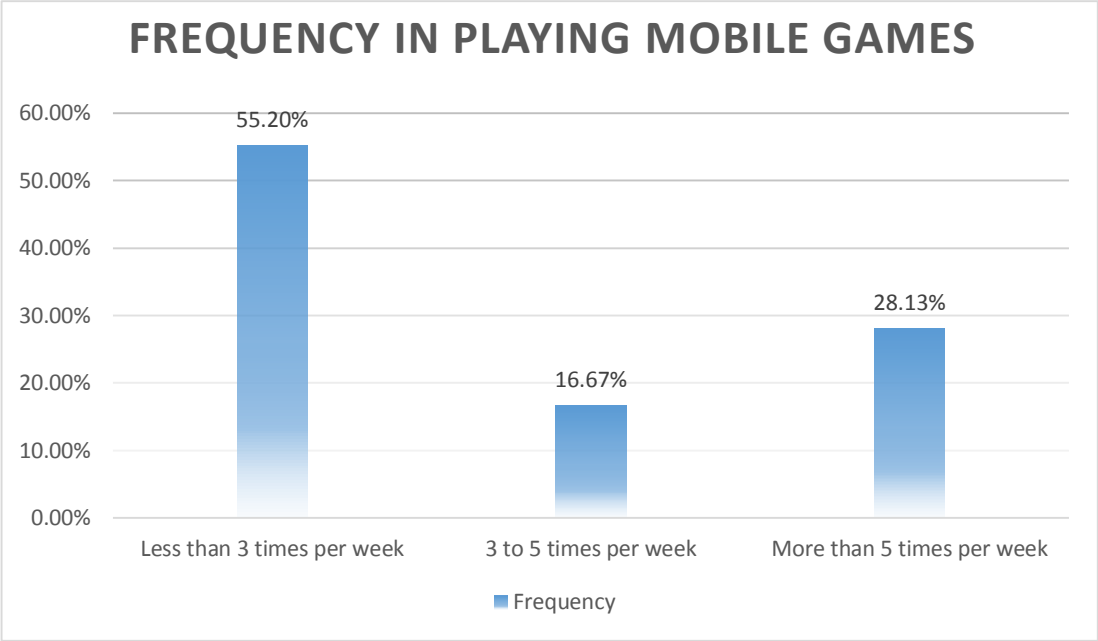

FIGURE 4.2: Frequency in Playing Mobile Games

(iii) According to the findings from the questionnaire, around half of the students (52.08%) use abacus to do mathematical calculation.

(iv) FIGURE 4.3 below shows the result on how the children feels about mathematics and abacus. Based on the findings as shown in FIGURE 4.3, majority of the children like mathematics. However, even though the children like mathematics, this does not mean they like using abacus as well. It can be seen in the graph where less students favour abacus as compared to mathematics.

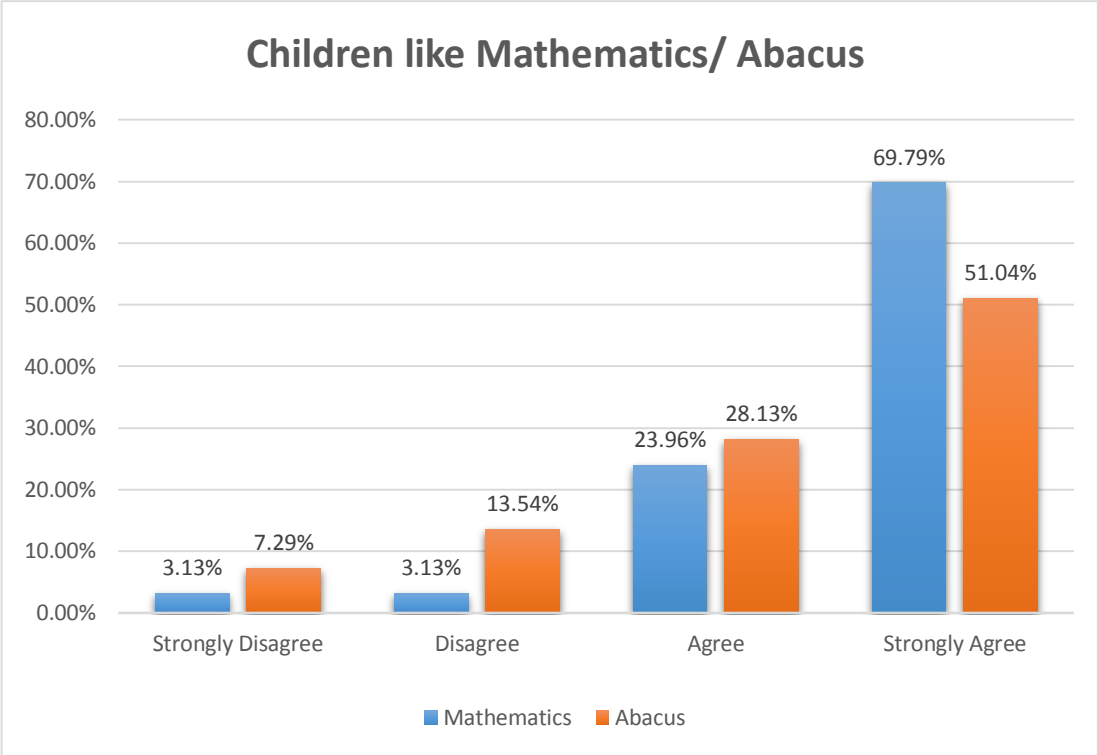

FIGURE 4.3: Children Like Mathematics/ Abacus

(v) According to FIGURE 4.4 below, 84.38% of the children are in the opinion that mathematics is very important however, only 55.21% of them agreed that abacus is as important as mathematics as well.

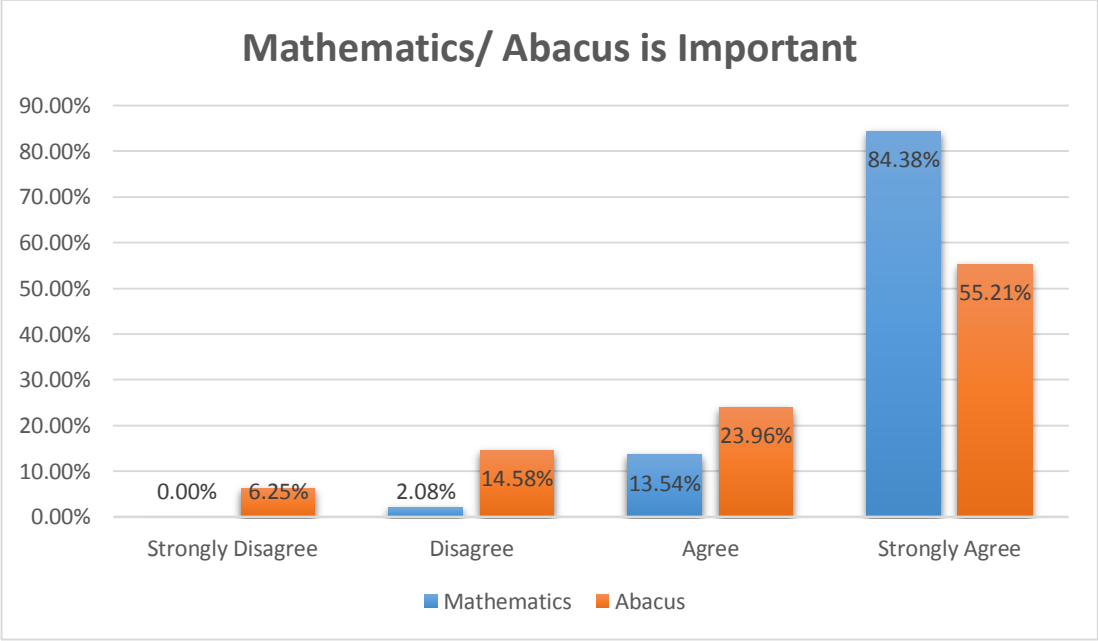

FIGURE 4.4: Mathematics/ Abacus is Important

(vi) Even though there are around 64.58% of the respondents claimed that the way teachers teach mathematics is interesting, only 54.17% agreed that abacus teaching method is interesting as well. This may be due to the ineffective traditional way of teaching abacus.

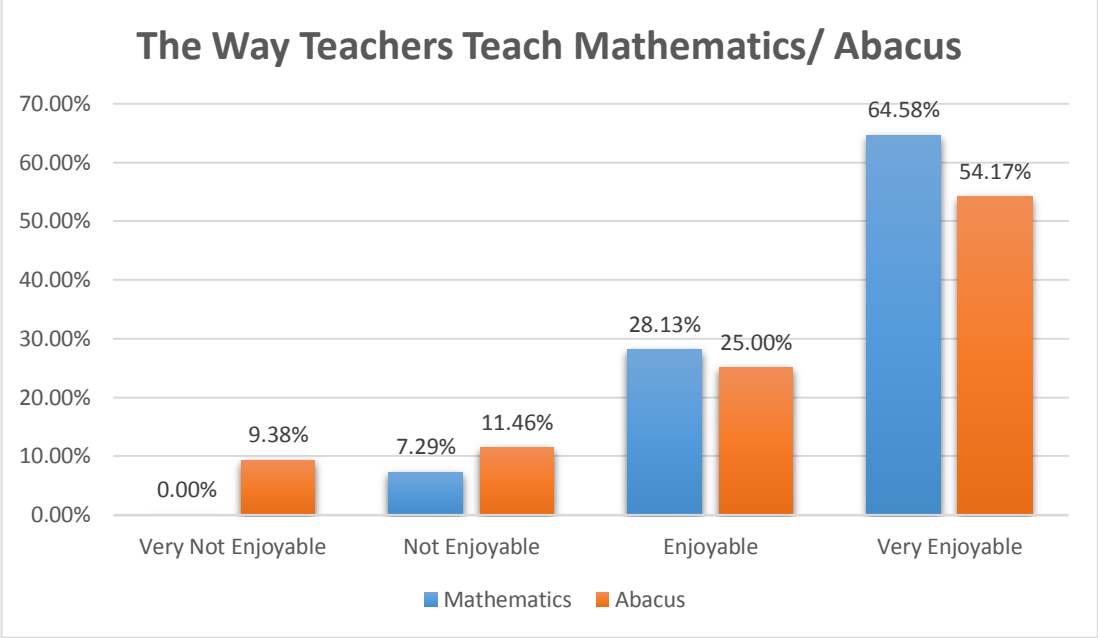

FIGURE 4.5: The Way Teachers Teach Mathematics/ Abacus

(vii) TABLE 4.1 below indicates the findings on whether learning via games is fun in the opinion of the respondents. It is obvious that majority of the respondents agreed that learning through games is fun including learning mathematics and abacus as well.

TABLE 4.1: Findings on Whether Learning through Games is Fun

Statement	Strongly Disagree	Disagree	Agree	Strongly Agree
Learning through games is fun	7.29%	2.08%	13.54%	77.08%
Learning Mathematics through games is fun	6.25%	6.25%	15.63%	71.87%
Learning Abacus through games is fun	13.54%	6.25%	21.88%	58.33%

4.1.2 Parents

A survey was also conducted with the guardians of the children as well. The survey was conducted using a set of questionnaires as shown in the APPENDIX 5. The target of this survey are the guardians of primary school students aged seven to twelve years old. The objective of the survey is to find out their opinion on mathematics subject, abacus and mobile games. These surveys have been distributed to them through the tuition teachers at Pusat Perkembangan Minda Riang (MRC Learning Center), Super Education Group (Pasir Puteh Branch), SJK (C) Chung San, Tronoh as well as posted online using Google Form.

A total of 51 respondents with the age range from 24 to 67 years old had participated in this survey. About 54.90% of them are females and 45.10% of them are males. They all come from different working background such as administrators, business consultants, accountants, chef, clerks, housewives, managers, engineers and teachers.

Based on the questionnaires conducted, the following findings were found:

(i) Up to 82.35% of the respondents own the Android smart phone and 58.82% allow their children to play with the smart phone. However, only 19.61% have ever downloaded the educational games for the children to play. Those who claimed that they downloaded the educational games before stated that they usually downloaded games such as 2048, Animal Puzzle for Kids, Daily Speak English, Learning Letter, Photo Maths, English Grammar, Kids Learning Number, English Song, Puzzle, Kids Math, Learning Japanese, Match N Spell, Lego and many more.

(ii) Majority of the respondents agreed that Mathematics is very important (78.43%) but less people agreed that Abacus is as important as Mathematics. However, there are still a total majority of 54.90% agreed that Abacus is important as shown in FIGURE 4.6. Those who agreed that abacus is important because they believe that learning abacus can train the children to think faster and develop their brain. On the other hand, those who think abacus is not so important simply because it is not the core subject in the school.

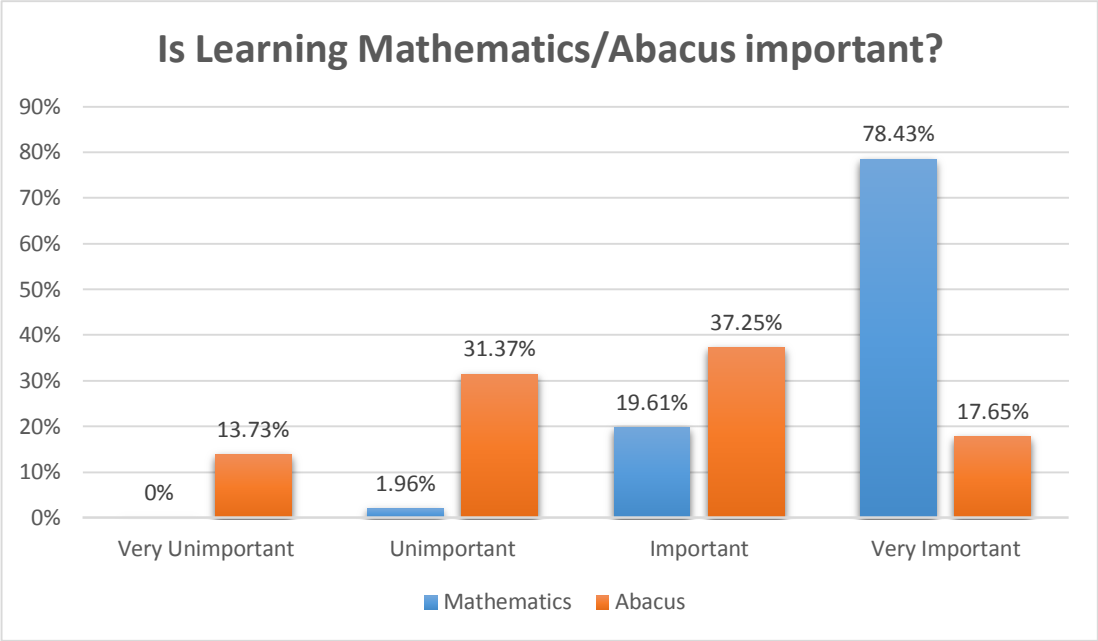

FIGURE 4.6: Learning Mathematics/ Abacus is Important?

(iii) FIGURE 4.7 below illustrated the opinion from the respondents on whether their children like Mathematics and Abacus. It is obvious that most of their children like Mathematics very much (39.22%) but not abacus (7.84%) as their children think that abacus is boring to learn and consists of repetitive exercises.

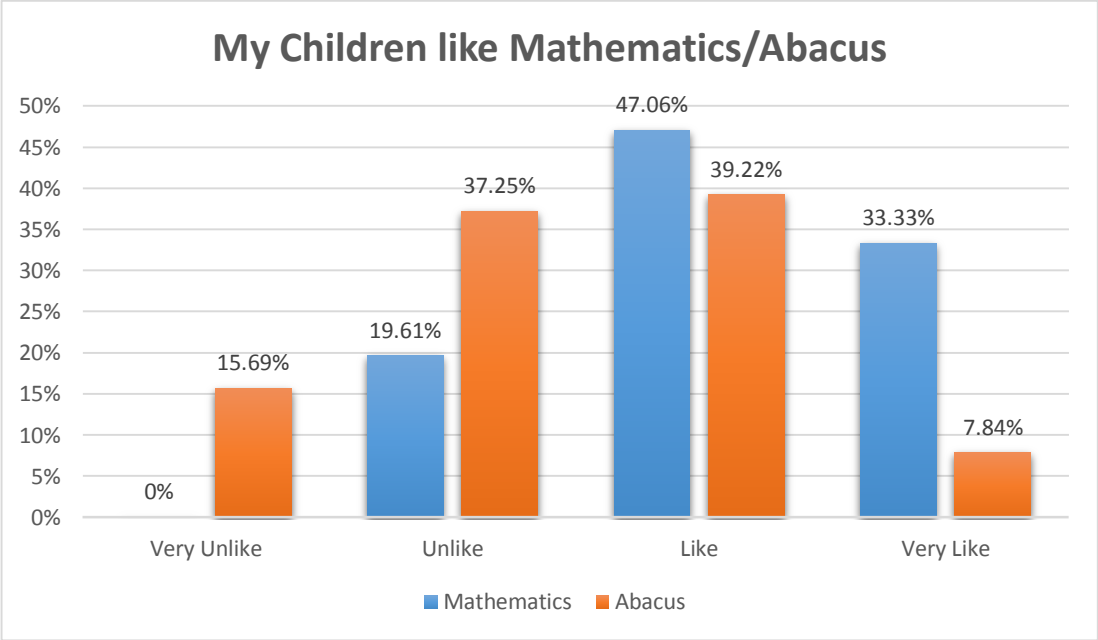

FIGURE 4.7: Respondents' Children like Mathematics/ Abacus

(iv) FIGURE 4.8 below shows the perspectives of the respondents on how well their children perform in Mathematics and Abacus. Majority of the respondents claim that their children perform well in Mathematics but only a total of 5.88% of the respondents strongly agreed that their children performed well in Abacus.

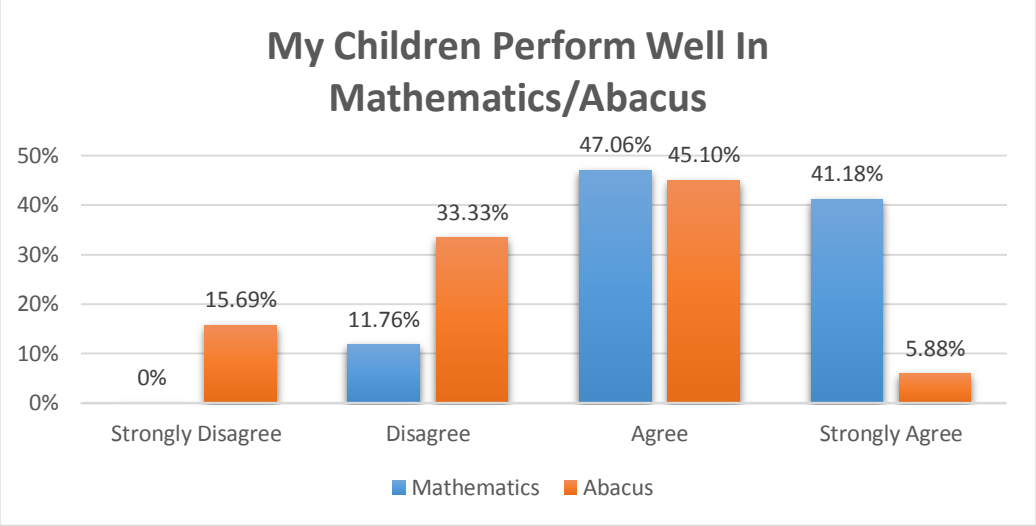

FIGURE 4.8: Respondents' Children Math/ Abacus Performance

(v) FIGURE 4.9 below shows the opinion of the respondents on whether the current teaching method of Mathematics and Abacus is effective. The result shows that the teaching method can only be considered as effective but not very effective according to the graph in FIGURE 4.9.

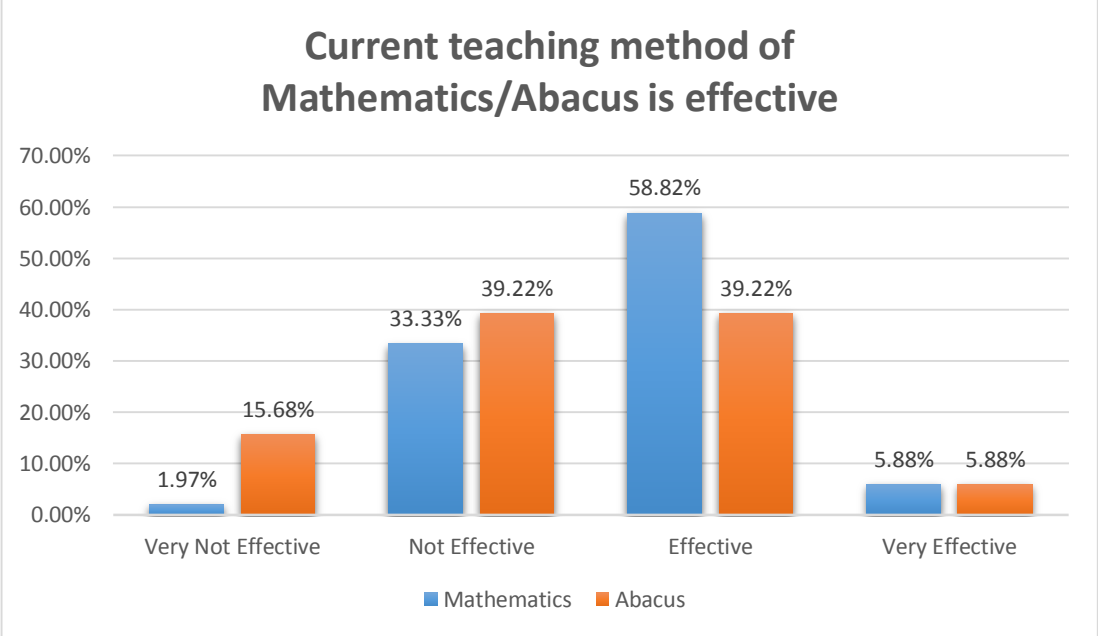

FIGURE 4.9: Current Teaching Method of Mathematics/Abacus

(vi) FIGURE 4.10 shows the opinion of the respondents on whether mobile game is a good way to teach abacus. Surprisingly only 11.76% strongly agree that mobile game is a good way to teach Abacus and 31.37% agreed with the statement. Those who support the statement believe that colourful or hand-on teaching method will attract children's attention and it is fun to play with mobile game. Moreover, it is easy to pick up abacus using mobile game since the tutorial of abacus is provided. On the other hand, those who disagree with the statement claimed that playing mobile games will affect the children's eyesight and some just simply do not let their children to play with the mobile phone.

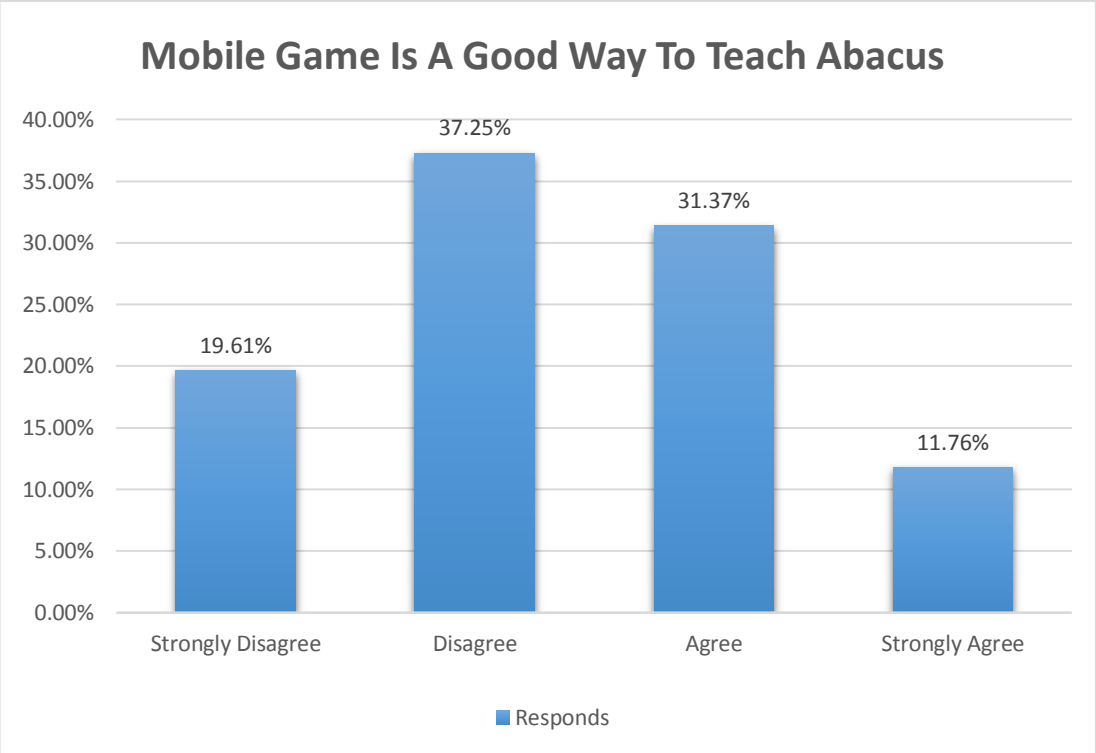

FIGURE 4.10: Mobile Game Is A Good Way to Teach Abacus

(vii) However, in conclusion as shows in FIGURE 4.11, 52.94% of the total respondents are still willing to give it a try on the abacus mobile game if it is available in the market.

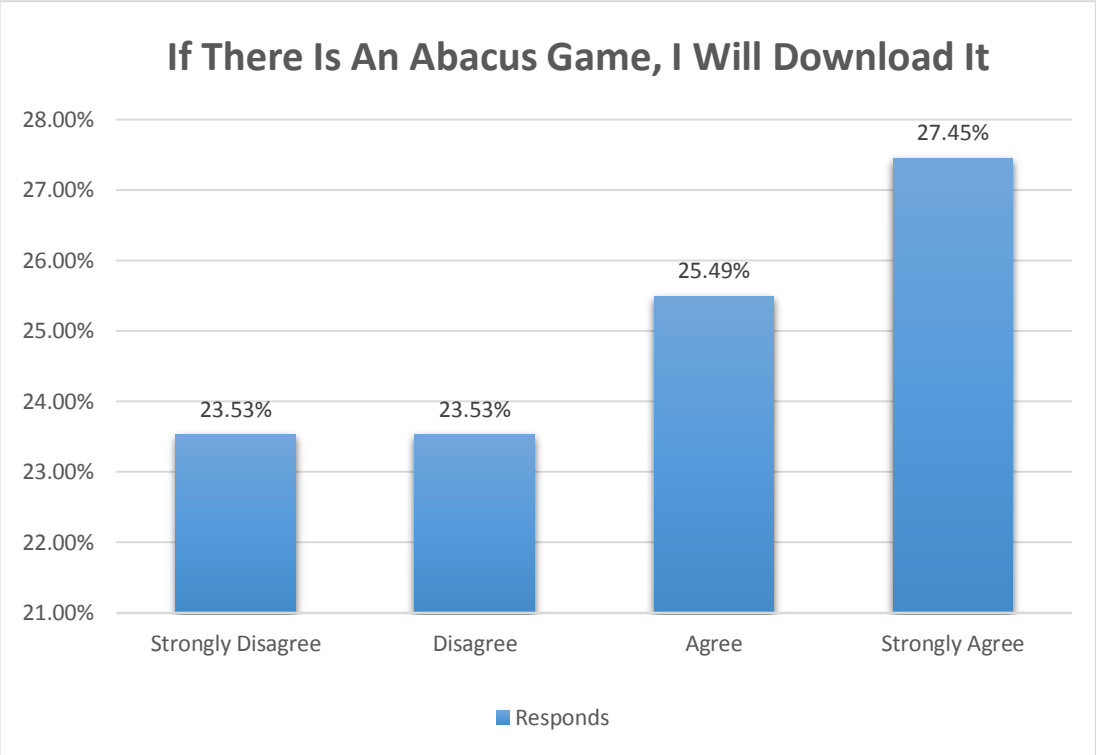

FIGURE 4.11: Download Abacus Mobile Game

4.2 Mobile Game Design

4.2.1 Flowchart

FIGURE 4.12 shows the general flowchart of how the prototype runs from one page to another. However, details explanations will be covered in the continuous section together with the snapshots of the interfaces for further understanding.

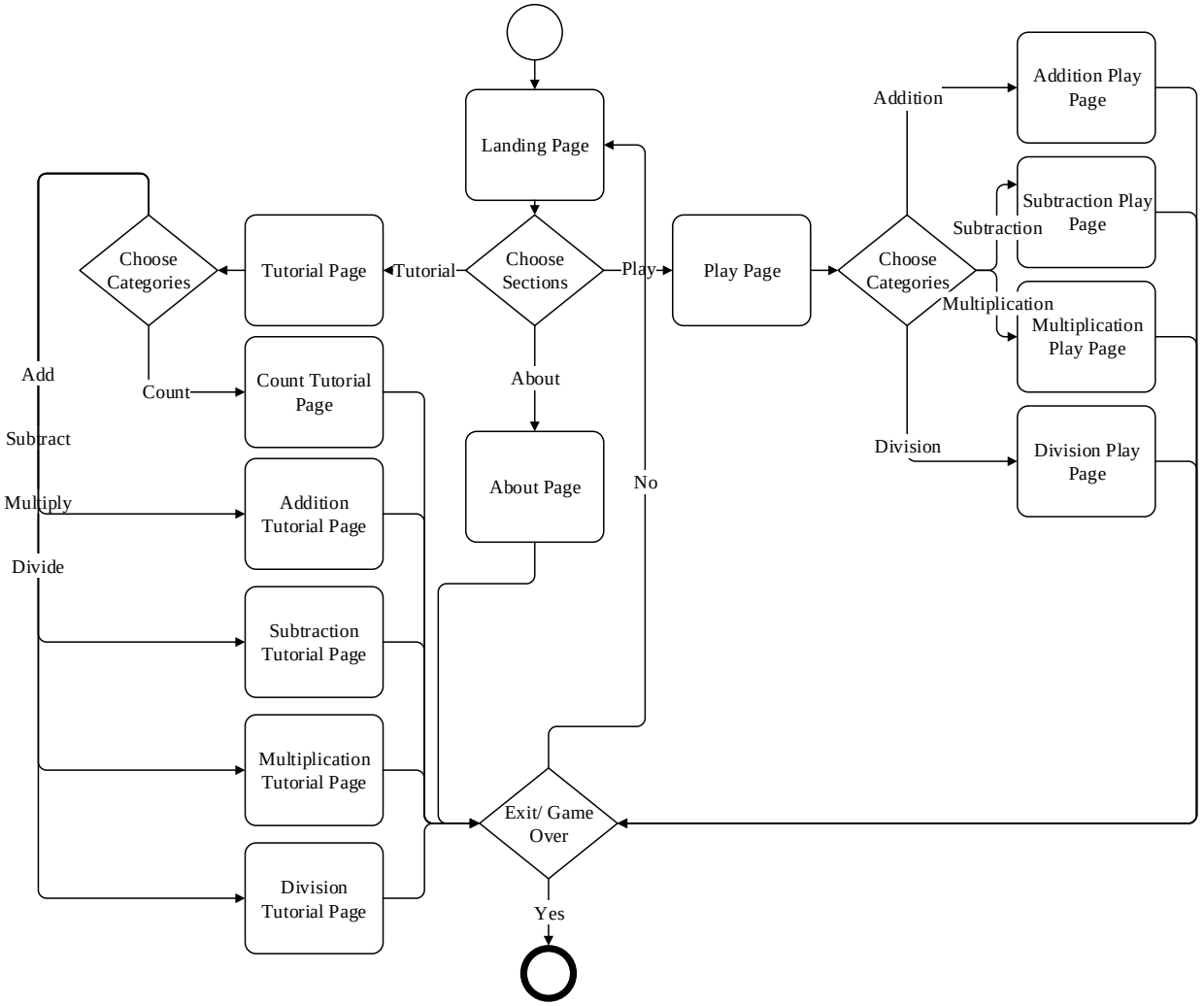

FIGURE 4.12: Flowchart of Prototype

4.2.2 Landing Page

FIGURE 4.13 below shows the landing page's interface of the mobile application. It consists of three main parts which are the "Tutorial", "Play" and "About". On the lower middle part, there is an "X" where user can tap on it to exit the application.

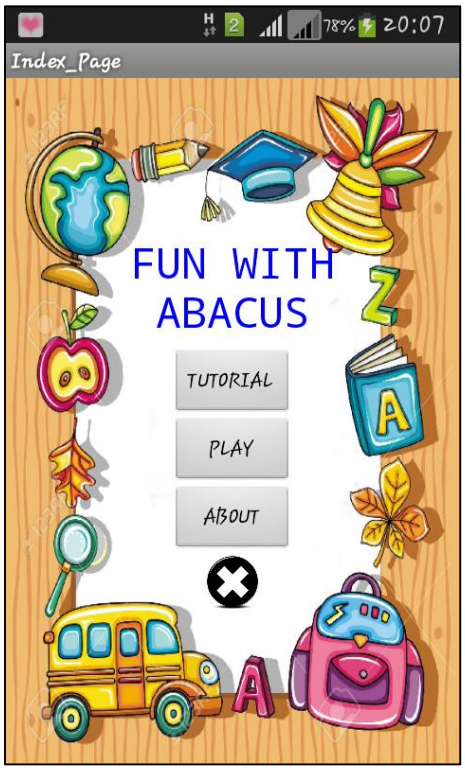

FIGURE 4.13: Landing Page

4.2.3 Tutorial

FIGURE 4.14 below shows the home page or landing page of the tutorial once the users click on the "Tutorial" button at the landing page as shown by the FIGURE 4.13. There are five categories in the tutorial where the users will first be taught on how to count the numbers using the beads, next proceed to the tutorial of addition, and followed with subtraction, multiplication and lastly division. The users can either learn following the sequence or choose the category that they want. At the left corner, there are three icons where the first one is the "Back" icon. Users can tap on it to go back to the previous page and also the "Home" icon where it will direct the users back to the landing page and lastly the "Exit" icon for the users to exit the application.

FIGURE 4.15 shows the example of interface for Multiplication Category, the tutorial comes in three forms which is the words as illustrated in the figure, the sound that read the tutorial and also require the users to move the beads by following the arrows. This tutorial is designed in this way is to take care of the users with the three different learning styles like visual, auditory and kinesthetic as discussed at Chapter 2. First, the user needs to click on the "Begin" button to start the tutorial. After that, the "Begin" button will change to "Next". The users can tab "Next" whenever they already know the particular part of lesson and proceed to the next part. There are also "Home" and "Exit" icons similar to the Tutorial Home Page.

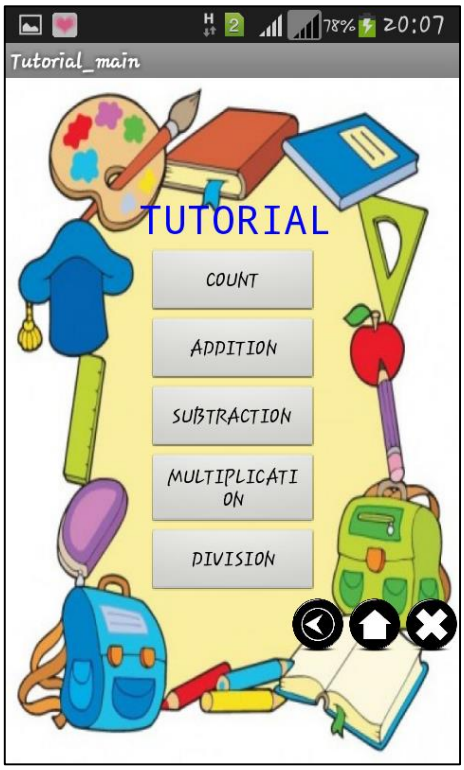

FIGURE 4.14: Tutorial Home Page

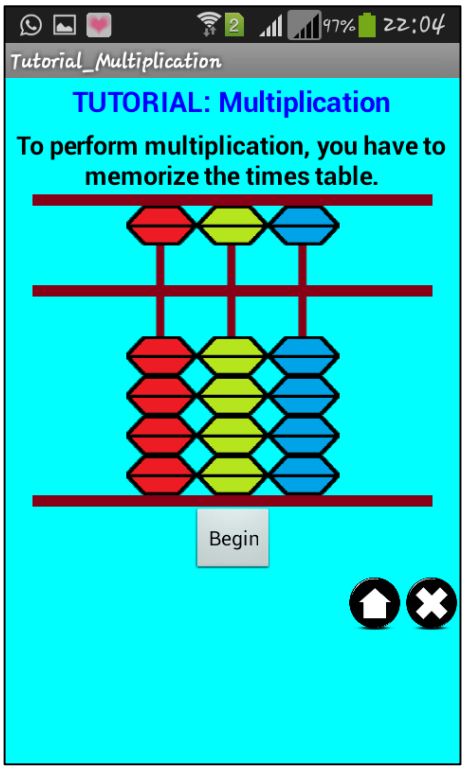

FIGURE 4.15: Tutorial For Multiplication

4.2.4 Play

FIGURE 4.16 shows the Play Home Page where users will be directed after clicking on 'Play' at the landing page. There are four main sections which are 'Addition', 'Subtraction', 'Multiplication' and 'Division'. The users can play based on the category they want. Similar at the left corner, there are "Back", "Home" and "Exit" icons.

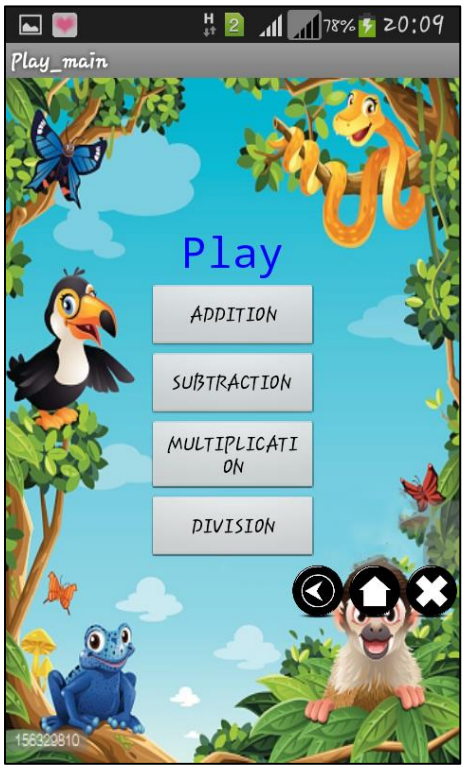

FIGURE 4.16: Play Home Page

FIGURE 4.17, FIGURE 4.18, FIGURE 4.19 and FIGURE 4.20 shows the interface of the game for all the sections where FIGURE 4.17 shows the interface for addition game, FIGURE 4.18 shows the interface for subtraction game, FIGURE 4.19 shows the interface for multiplication game, FIGURE 4.20 shows the interface for division game. Whenever the game starts, there will be a blue bird moving down from top to reach the red target. The players need to perform the correct calculation using the abacus as fast as possible before the bird gets shot by the target. There are “Home” button and “Exit” button as well in the Play interface.

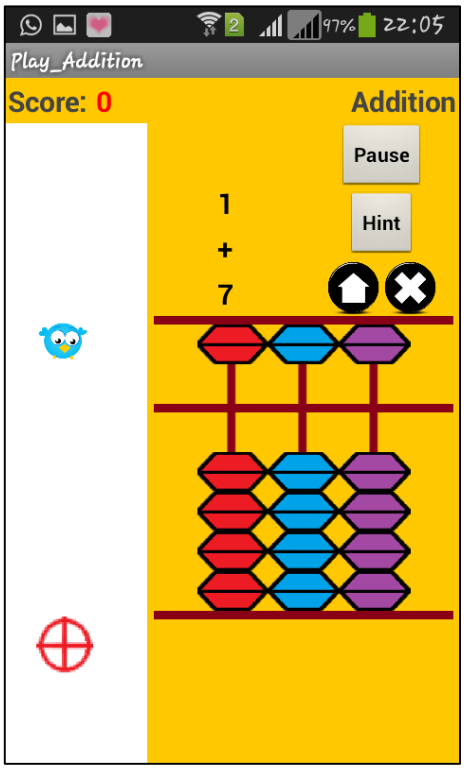

FIGURE 4.17: Play Addition

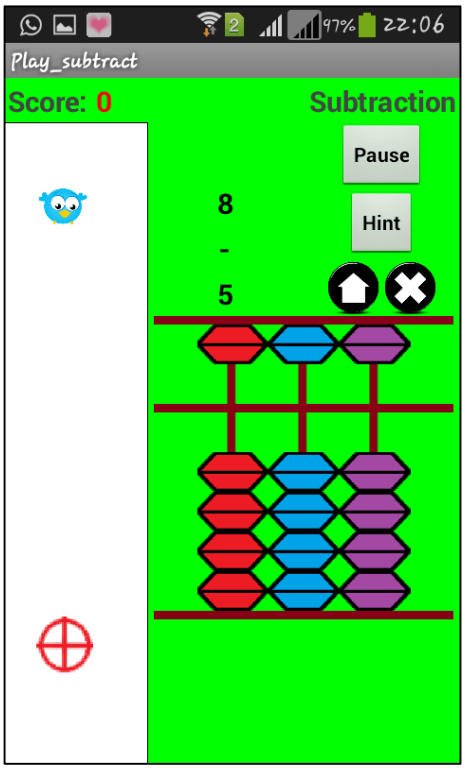

FIGURE 4.18: Play Subtraction

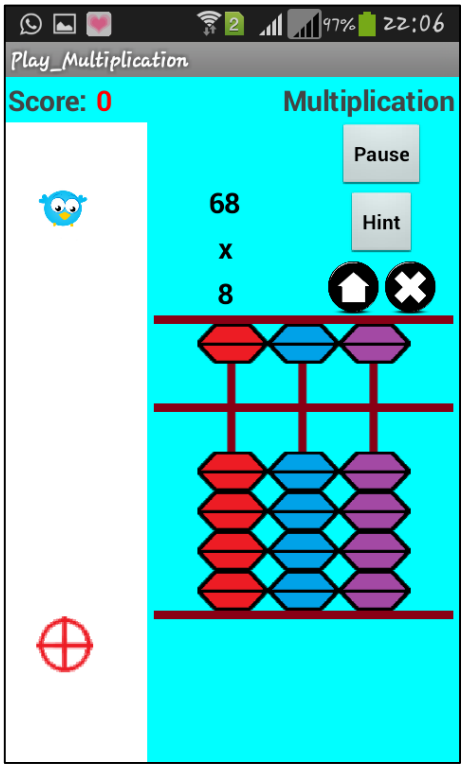

FIGURE 4.19: Play Multiplication

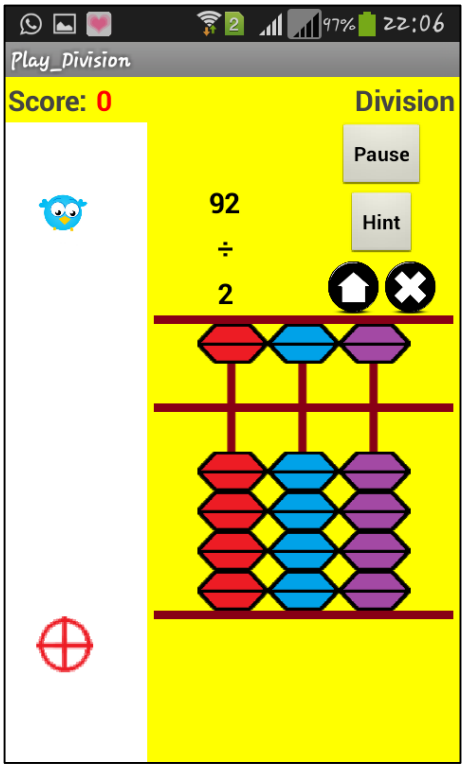

FIGURE 4.20: Play Division

As shown in FIGURE 4.21 and FIGURE 4.22, when the bird reached the target, the player will lose. The player can choose “Play again!” to play again or “Give up!” to back to the Play Home Page.

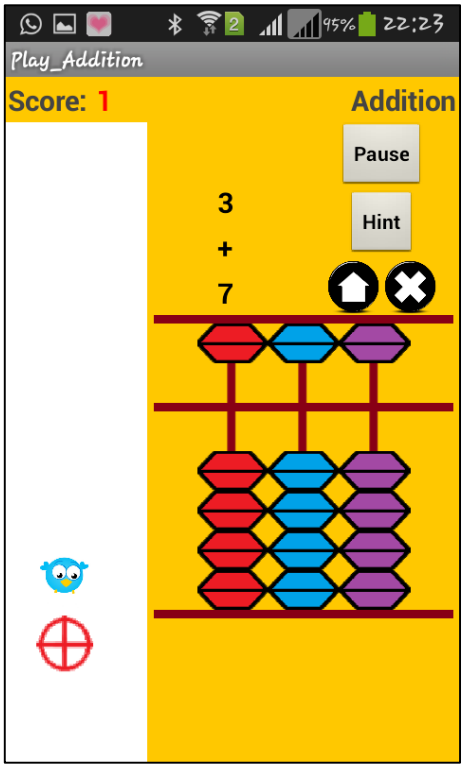

FIGURE 4.21: Target

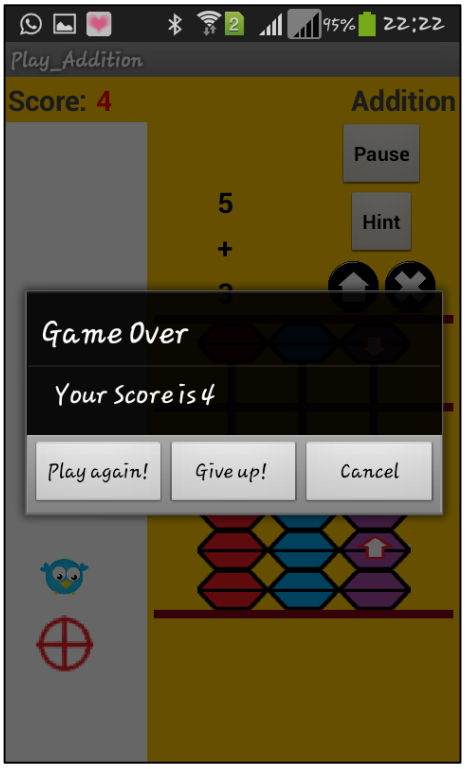

FIGURE 4.22: Game Over

If the users forget how to perform the correct calculation of the abacus, they can click on the “Hint” at the right top corner and arrows will appear at the abacus to guide the players to move the beads correctly as shown in FIGURE 4.23. The users can also click on pause to pause the game and resume back whenever they want.

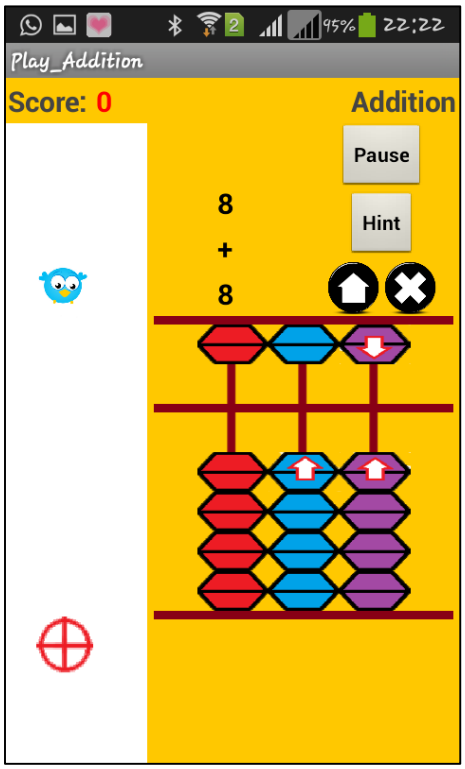

FIGURE 4.23: Hint When Play

4.2.5 About

FIGURE 4.24 shows the “About” page of the application. Users will be directed to this page once the users click on the “About” button at the landing page. At this page, a brief description of the “Fun With Abacus” mobile game is written down to let the users know more about the mobile application.

FIGURE 4.24: About Page

4.3 User Acceptance Testing

To determine whether the application developed meets the objectives of the project, user acceptance testing is conducted. User acceptance testing also known as usability testing. It is a black box testing which examines the functionality of an application without peering into its internal structures or workings. The user acceptance testing is done with two different groups, one is with the primary school children and another one is test with the parents and teachers.

4.3.1 Children

To conduct the user acceptance testing with the children, 11 primary school children were asked to use the mobile application while their behaviour was recorded. This was done to identify the children reaction toward the mobile application as well as the effectiveness of the application. In order to compare the different between using mobile game and manual method to learn abacus, before the children were given the mobile application to use, they were asked to complete a set of questions which consists of 10 addition problems (refer to APPENDIX 6). Their time taken to solve all the question manually was recorded.

63.64% of the children are male whereas 36.36% are female. FIGURE 4.25 shows the age of the children who are involved in the usability testing.

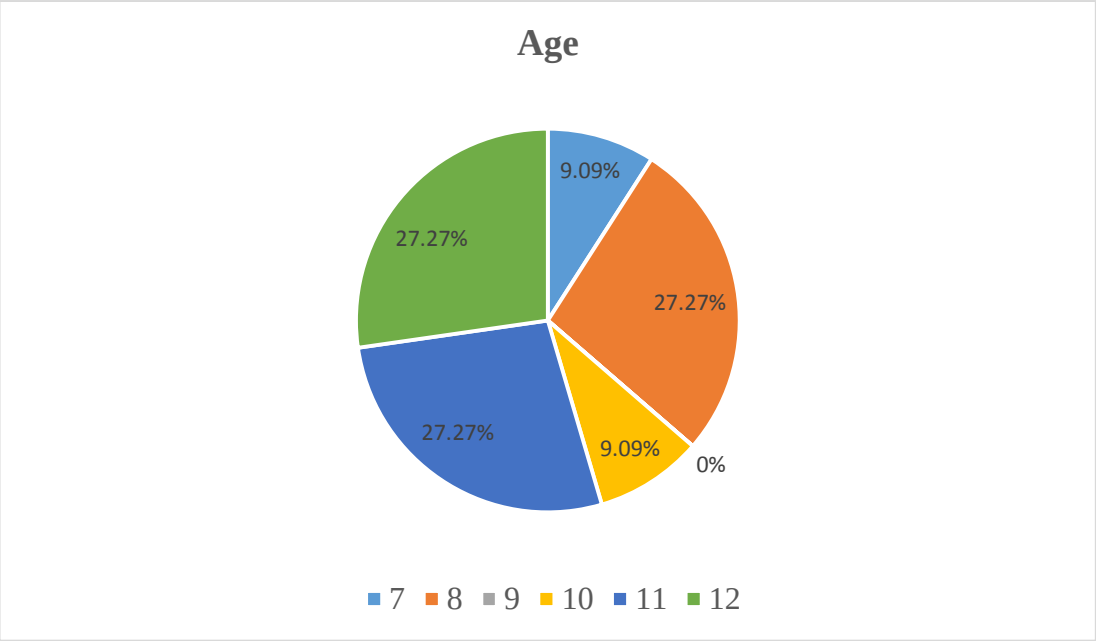

FIGURE 4.25: Age of the Children

From the data collected during the manual calculation performed by the children, the average time taken to complete the 10 addition questions is around 1.02.19 minutes. The shortest time taken to complete the set of question is 18 seconds which is done by an eleven years old boy. Whereas the longest time taken is 1.53.57 minutes which is done by a ten years old girls.

On the other hand, the average time taken to get 10 score when playing the mobile game is 1.02.07 minutes which is slightly faster than the average time taken to complete the question set. The shortest time taken is 15.89 seconds which is done by a twelve years old boy and the longest time taken is 1.35.14 minutes which is done by an eight years old boy.

Below are the respondents who have done the User Acceptance Test for the mobile application. In FIGURE 4.26, the first respondent, 8 years old is a hyperactive child. He cannot sit still for long period and has concentration problem. However he was very excited when handed over with the mobile game.

Some observation on him while using the application are:

- He was excited while using the application, he likes thing with sound and music
- Touched the right points on the screen after being instructed once
- He can use the application very well after a few time of try and error
- Did very well in the game section and able to follow the instruction in tutorial.
- He did not want to let go the phone even after being told that the testing is over.
- Compare with the paper test, he is more interested in the abacus mobile game and he feels sense of accomplishment when he gets high marks

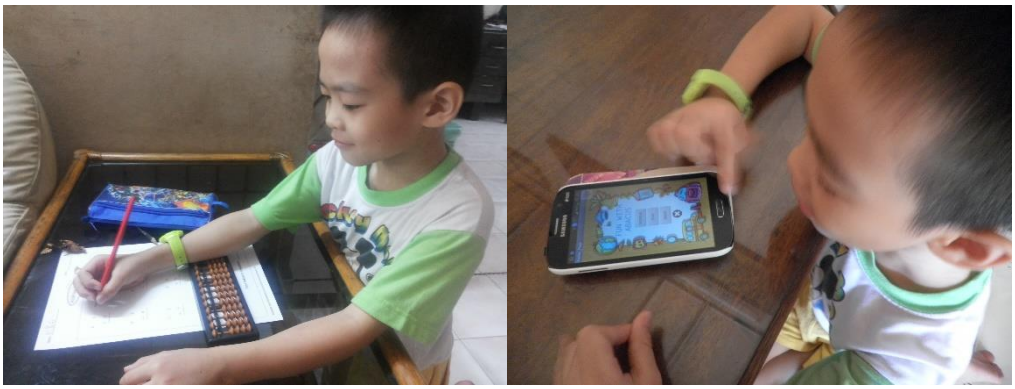

FIGURE 4.26: Respondent 1

The second respondent is a 10 years old girl. She learned abacus before. Some observation on her while using the application are:

- Her facial expression was normal when using the device, nothing much expression.
- She tried to cope with the game
- She faced some difficulties in the home page, after being instructed, she was able to understand the menu page.
- At first, her speed in playing the game is moderate
- She kept on trying when she did not get the right answer, with few more attempts, her speed in playing the game became faster.

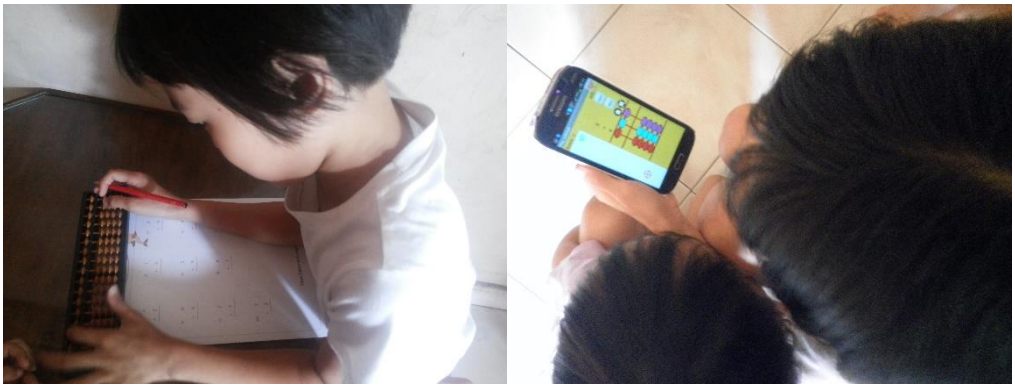

FIGURE 4.27: Respondent 2

The third respondent is an 8 years old boy. He is very smart. He is quite sensitive with number and can calculate very well. Some observations on him while using the application are:

- He seemed happy to see the application
- He is able to touch on the correct points on the screen without any help
- He counted correctly for all the questions that he had attempted with a fast speed.
- When he heard the sound after he got the correct answer, he was very happy and excited.

FIGURE 4.28: Respondent 3

The fourth respondent is a 12 years old boy. Maybe of his older age, he is not so interested in the game and feels that the game is too easy for him. Some observations on him while using the application are:

- He seemed not so interested in the game
- For him, the game looks like too easy.

- He managed to get 62 marks after played the game for less than one minute.
- He can navigate the application by himself without any help needed.

FIGURE 4.29: Respondent 4

The fifth respondent is an 8 years old boy. He is not so sensitive with number. Some of the observations on him while using the application are:

- He was scared with the observer during the testing
- He faced some difficulty at the beginning in understanding the menu page.
- After instructed for a few time, he was able to cope with the application
- He is not familiar with abacus. Hence, he faced some difficulty when playing the game.
- He gamed over for a few time because he thinks that the bird drop down too fast.

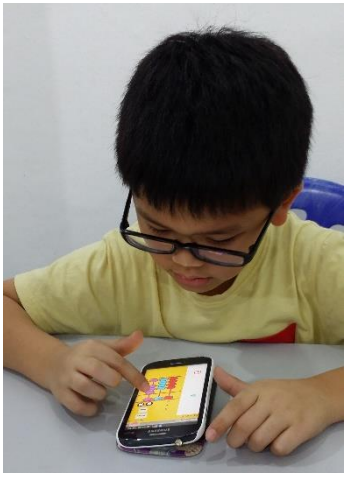

FIGURE 4.30: Respondent 5

The 6th respondent is an 11 years old girl. She is very clever. According to her tuition teacher, her mathematics is very good. Some observations on her are:

- She was happy while using the mobile application.
- She can calculated very fast
- She did not face any problem when navigate through the application
- She is interested in the mobile game

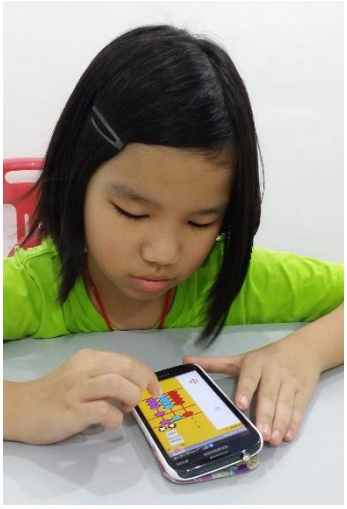

FIGURE 4.31: Respondent 6

The 7th respondent is an 11 years old boy. He is quite naughty. Some observation on him are:

- His facial expression is frown while using the application.
- He was shock when he was asked to play the abacus game as he does not know how to use the abacus at all and his English is not well.
- However, with some guidance, he started to like the mobile game.
- With several attempts, he feels that the game is quite enjoyable as compared to what he taught at first.

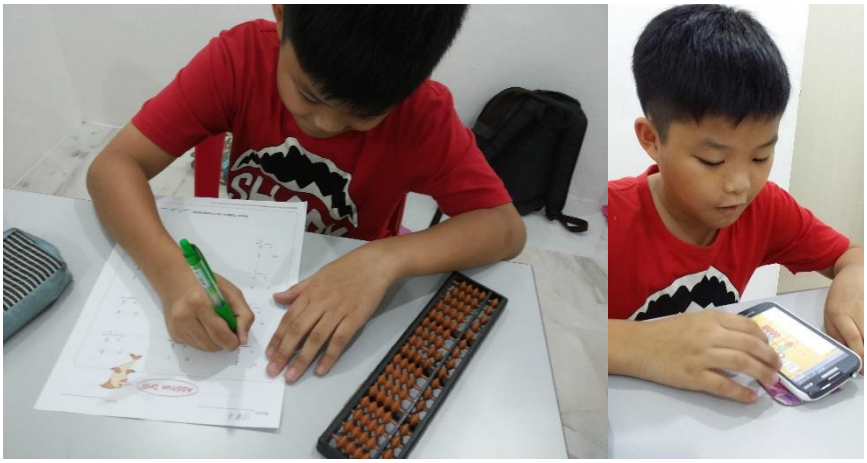

FIGURE 4.32: Respondent 7

The 8th respondent is a 12 years old girl. According to her tuition teacher, she is a slow learner. Some observation on her are:

- Her facial expression is frown while using the application.
- She seemed not so interested with the application.
- Her English is not very well, hence she faced difficulties in understanding the instruction.
- However, she understands the arrows at the bead means that to ask her to push up or push down.
- With several attempts, she can cope with the game but her speed in playing the game was slow.

FIGURE 4.33: Respondent 8

The 9th respondent is a 12 years old girl as well. She learned abacus before and perform quite well in abacus. Some of the observations on her are:

- Her facial expression is normal while using the application
- She can search for the right button without guidance.
- She understands all the instructions in the Tutorial section
- She performed better using the mobile application compared to the question paper

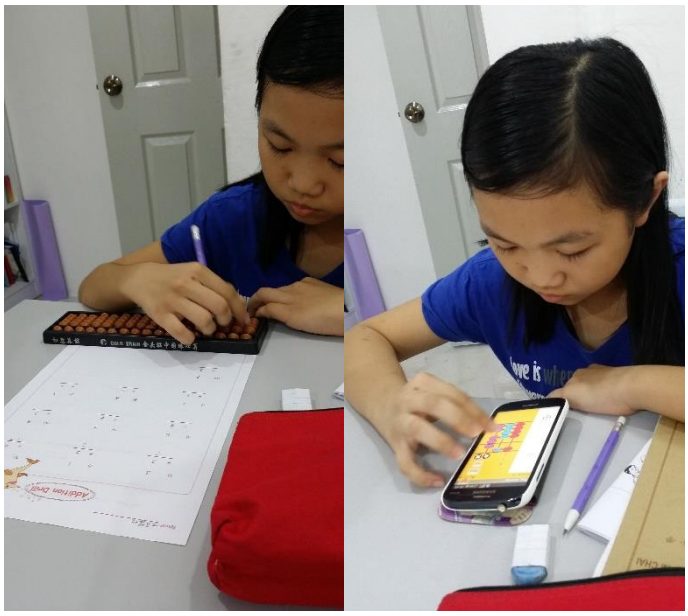

FIGURE 4.34: Respondent 9

The 10th respondent is a 11 years old boy. He likes game very much. Some of the observations on him are:

- He smiled and seemed very happy while using the mobile application
- He can understand the menu page and can search for the correct buttons.
- He never learns abacus before but he can master it in a short while.
- He was able to input the correct answer for almost every question.

FIGURE 4.35: Respondent 10

The last respondent is a seven years old boy. He is quite intelligent. He is a fast leaner. Some observations on him are:

- He was very happy and excited while using the mobile application
- He was able to navigate throught the application after instructed once.
- He was able to push the right beads and understand the instrcution in the Tutorial section.
- His speed in playing the game is moderate.

FIGURE 4.36: Respondent 11

As attached in the Appendix 7, an observation checklist was designed to record the reactions from the children when performing the usability testing. The checklist was designed with certain elements.

The first element that has been assessed is the respondents' expression. Based on the observation, 45.45% of the respondents were very happy and excited with the mobile

application, and only 27.27% of the respondents were not interested in the application. This shows that their emotion varies and difficult to predict.

The second element is to identify whether the interface is easy to navigate. From the observation, only 27.27% of the respondents have some difficulties in understanding the menu page and clicked the wrong button. Majority can search and click the correct button by themselves or with just a guidance for once.

The third element is to find out whether the Tutorial section is useful in guiding the children to learn abacus. The result shows that the majority of the children can follow the instruction and understand the tutorial. Those who have problem in understanding the tutorial are mainly because they are not good with English language.

The fourth element is about the game section. From the observation, the colourful setting and sound have attracted the children to be interested with the game. They were able to cope with the game without much guidance needed as compared with the tutorial section.

Therefore, it can be concluded that this mobile application is suitable to be used by the primary school children. However, it is adviced that the teachers or parents give some guidance for the first time users. Besides, the timing of the game and some instructions in the tutorial section need to be adjusted to suite the different levels of primary school children as some of them are quite clever whereas some are slow learners.

4.3.2 Parents & Teachers

Apart from the children, the user acceptance test has conducted with parents and teachers too to identify the adults' perception on this mobile game. First, the respondents were given the mobile application to play on. After that, they were asked to fill out a feedback form as shown in the APPENDIX 8 in order to record their opinion. The information gathered will be used to improve the functions and effectiveness of the application.

A total of 14 respondents with the age range from 22 to 61 years old had participated in this usability testing. About 64.29% of them are females and 35.71% of them are

males. They all come from different working background such as administrators, chef, clerks, housewives, managers, engineers, teachers and so on.

FIGURE 4.37 shows the pictures when the parents and teachers playing with the mobile game and filling out the feedback form.

FIGURE 4.37: Respondents for Usability Testing

Based on the questionnaires conducted, the following findings were found:

(i) FIGURE 4.38 shows the feedback of the respondents towards the application itself. 35.71% of the respondents strongly agree that the application has a user friendly graphical user interface and 64.2% of the respondents also agree that the design is user friendly. The respondents claimed that the colourful setting will attract the children to use the application. Furthermore, majority of the respondents think that it is easy to navigate through the application without much instruction or help needed. Besides, there are 71.43% of the respondents strongly agree that the mobile application is easy to use.

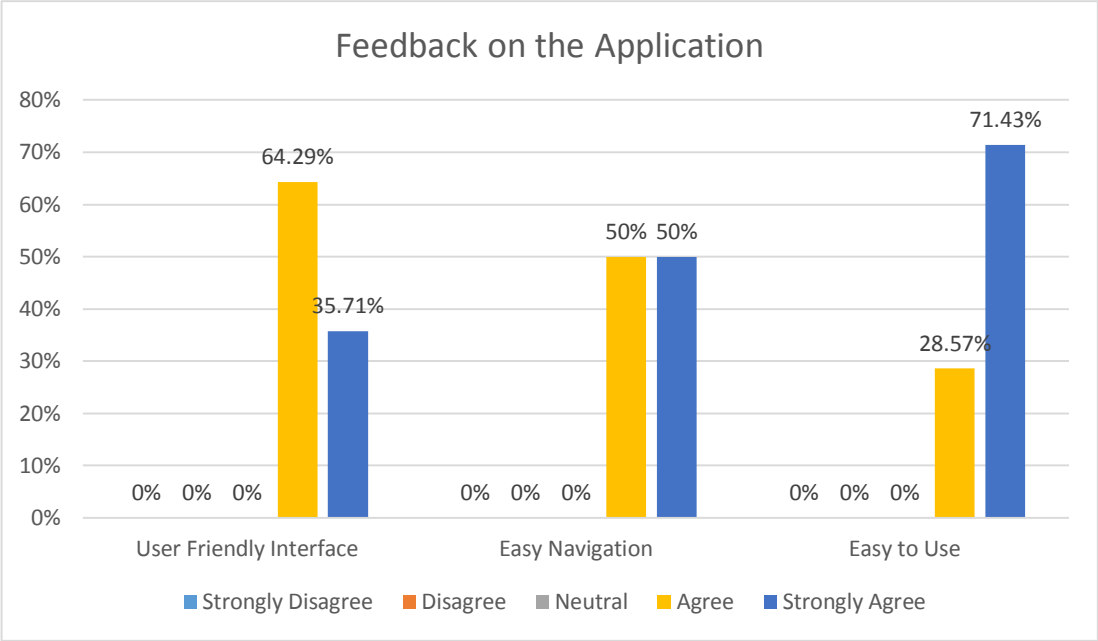

FIGURE 4.38: Feedback on the Application

(ii) Most of the respondents have not learned abacus before, by going through the tutorial, they can master the counting part in a very short time. Hence, 57.14% of the respondents comment that the tutorial is easy to understand as shown in FIGURE 4.39.

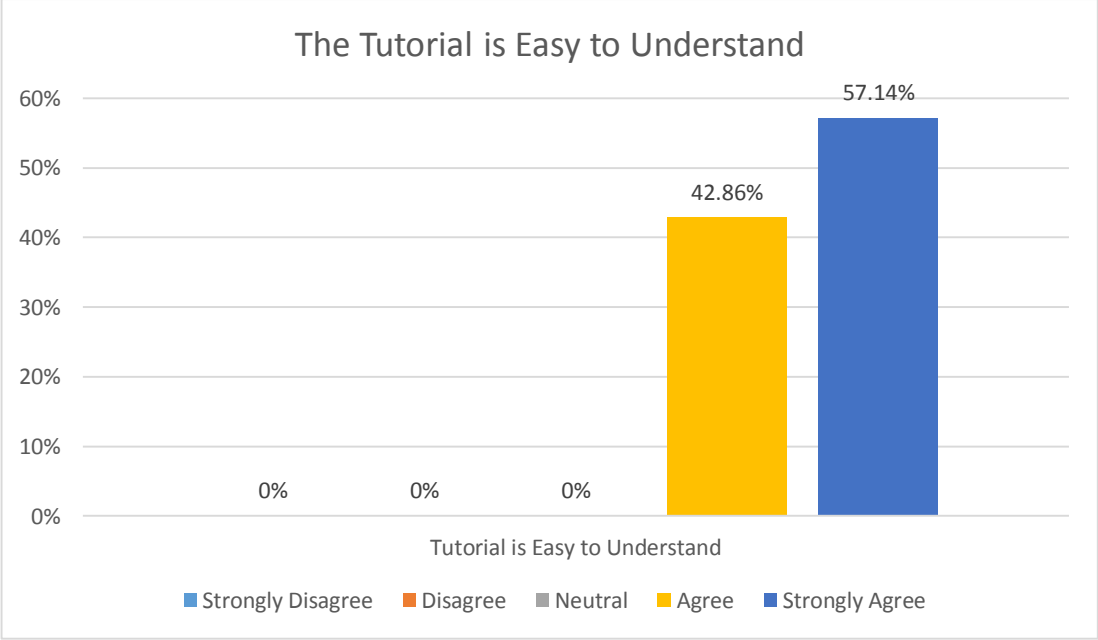

FIGURE 4.39: The Tutorial is Easy to Understand

(iii) The respondents tried to play the game after they learned the basic abacus counting. After played with the mobile game, majority of them agree that the game is fun to play. Some of them stated that the game is easy to play even though they have not learn abacus before.

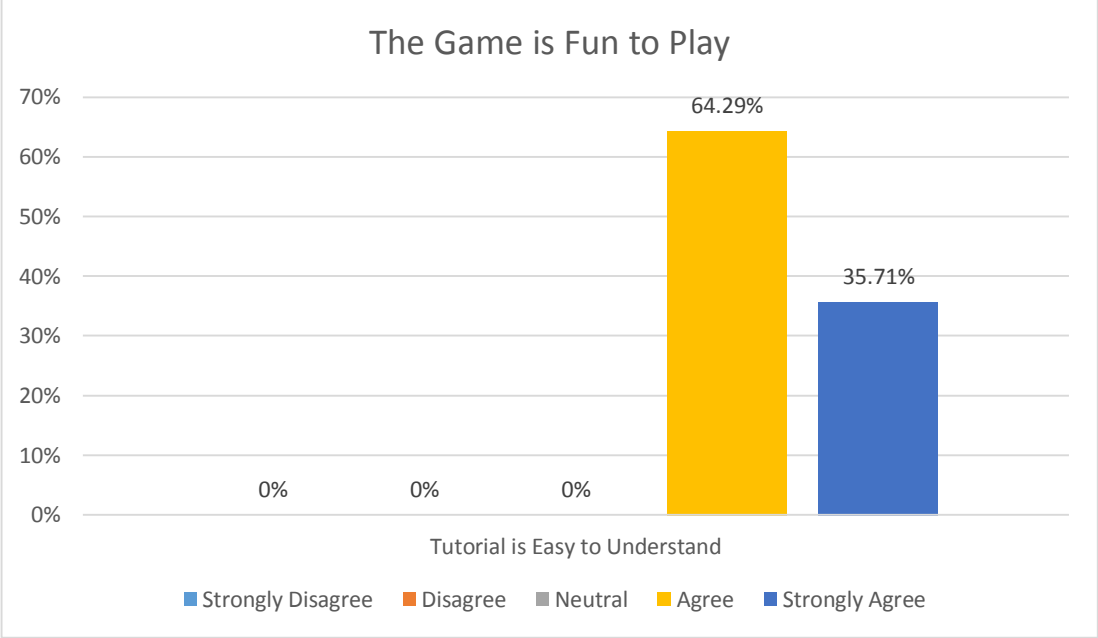

FIGURE 4.40: The Game is Fun to Play

(iv) When asked about whether the application is suitable for the primary school children, more than half, which is 57.14% strongly agree that the application is attractive, interactive and suitable for the primary school children. Moreover, 57.14% strongly agree that with the help of this mobile application, the children can learn abacus in a more effective and fun way.

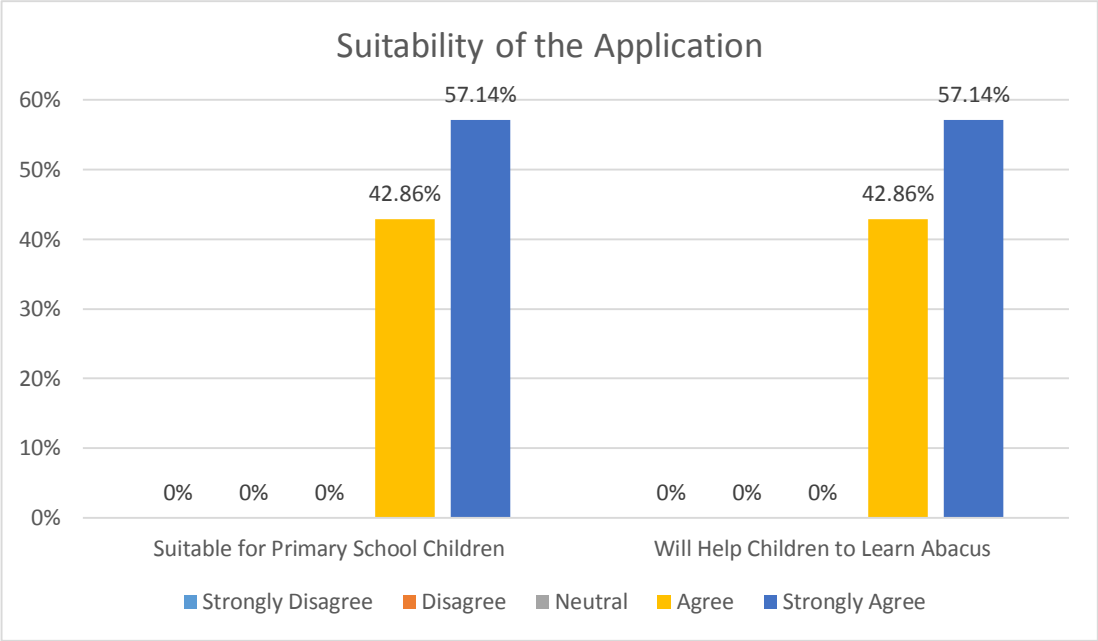

FIGURE 4.41: Suitability of the Application

(v) Based on FIGURE 4.42, majority of the parents and teachers said that they are interested in using the application and total 100% of the respondents agree that they will recommend this application to the primary school children to act as an alternative to learn and practice abacus as shown by FIGURE 4.43.

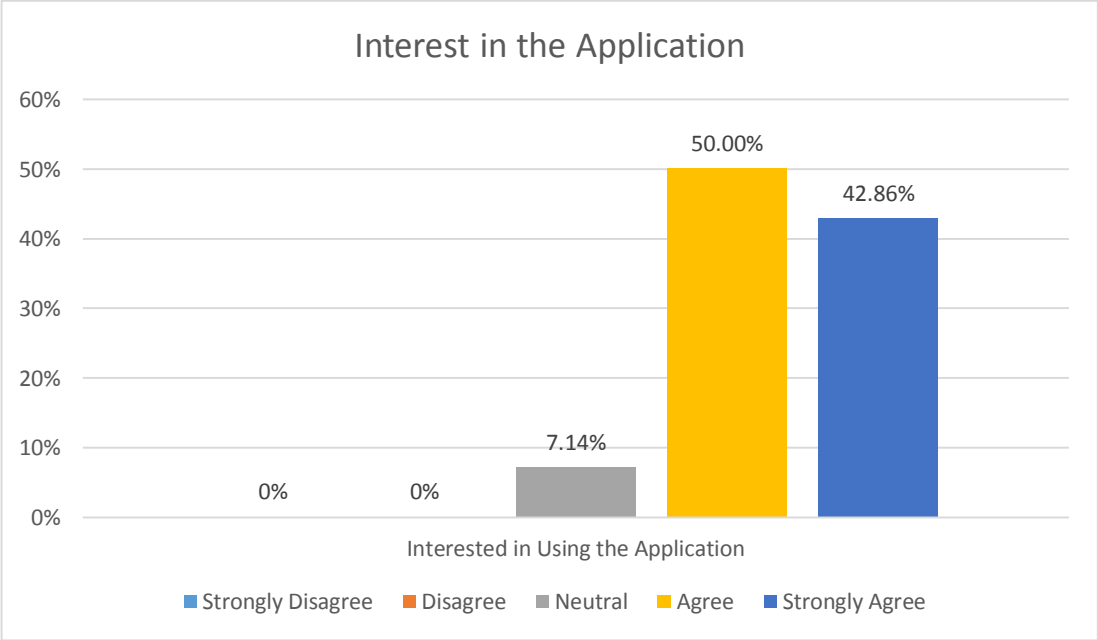

FIGURE 4.42: Interest in the Application

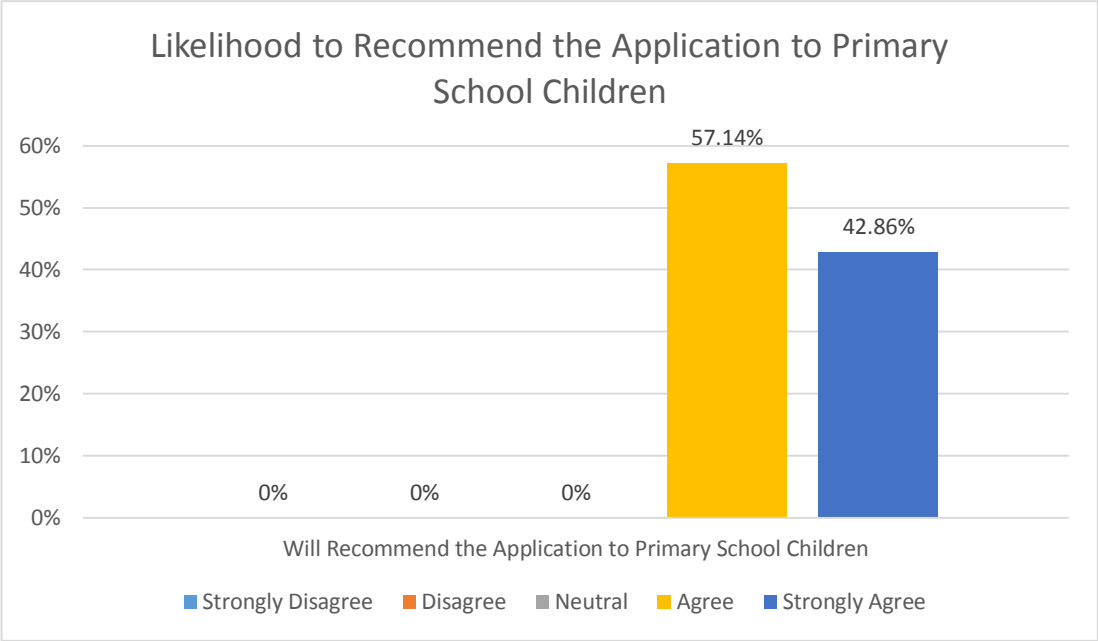

FIGURE 4.43: Likelihood to Recommend the Application to Primary School Children

CHAPTER 5
CONCLUSION

5.1 Conclusion

In conclusion, the mobile game acts as an alternative for the children to learn abacus. The mobile game is used to attract the children to be interested in learning abacus. All the objectives of this project have been achieved. The objectives achieved are to identify the learning styles of children and curriculum of abacus suitable for the primary school students, to develop an abacus mobile game on Android operating system and to evaluate the user acceptance on the developed mobile game. The children's learning styles and curriculum of abacus have been studied. The most suitable and effective learning method for the children to learn new knowledge is through the combination of different learning approaches into one learning tool. It is proven based on the research done through literature review as well as the responses received from the user acceptance test. A mobile game has been developed using MIT App Inventor and has been tested to verify that it meets the requirements of the targeted users. Hopefully this application with the suitable learning theory will be beneficial to the primary school children in learning abacus.

5.2 Recommendation

The mobile application still need some improvements in making it more complete and commercial based on the feedbacks and comments from the users via testing and surveys. First, the timing of the game need to be adjusted to accommodate the different needs of the children with different levels. In the future version, it is suggested that different levels of game such as easy, medium and hard will be added. Next, the tutorial

needs to be more details to let the children have a clearer understanding. In addition, a high score function should be added to record the highest score of the user so that they will have the sense of accomplishment and also to drive them to practice more in order to get a higher score.

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APPENDIX

PEJABAT KETUA PENGARAH PENDIDIKAN MALAYSIA,
KEMENTERIAN PENDIDIKAN MALAYSIA,
PARAS 7, BLOK J,
PUSAT BANDAR DAMANSARA,
50604 KUALA LUMPUR.

Telefon: 03-20983120
Fax: 03-20935150
Laman Web: http://www.moe.gov.my

KP(BS)8591/Jld. XVII(2)
19 Februari 2004

Semua Pengarah Pendidikan Negeri

Y.Bhg. Datuk/Dato'/Tuan,

SURAT PEKELILING IKHTISAS BIL. 2/2004
PELAKSANAAN PROGRAM ABAKUS DAN ARITMETIK MENTAL TAHAP 1 SEKOLAH RENDAH

Surat Pekeliling Ikhtisas ini dikeluarkan dengan tujuan untuk memaklumkan tentang pelaksanaan **Program Abakus dan Aritmetik Mental** dalam pengajaran dan pembelajaran Matematik Tahap 1 Sekolah Rendah.

2. Untuk menjayakan pelaksanaan program ini, perkara-perkara berikut perlu diambil perhatian :

2.1 Abakus digunakan dalam pengajaran dan pembelajaran matematik bagi membolehkan murid menguasai pengiraan secara mental.

2.2 Abakus yang digunakan dalam program ini ialah dari **Jenis 4-1** dan manik mestilah **berwarna putih sahaja**.

2.3 Dalam sesuatu pelajaran matematik, abakus digunakan untuk pengukuhan konsep dan kebolehan mengira.

2.4 Sebanyak **2 waktu daripada 7 waktu seminggu** bagi pengajaran Matematik Tahap 1 hendaklah digunakan. Dalam 2 waktu pengajaran ini, guru boleh menggunakan abakus sebagai alat bantu mengajar dalam melaksanakan Kurikulum Matematik KBSR.

2.5 Guru yang mengajar hendaklah guru yang telah mendapat latihan daripada Jurulatih Utama Abakus di 6 zon seluruh negara.

2.6 Pengajaran abakus dan aritmetik mental di Tahun 1 hendaklah dimulakan setelah murid sudah mahir dan mengenal nombor dengan baik.

APPENDIX 1: Circular Issued by the Ministry of Education to make Abacus Compulsory in Primary School (Page 1)

3. Pelaksanaan program ini di Tahap Satu Sekolah Rendah bermula tahun 2004, adalah seperti jadual berikut:

TAHUN	TAHUN PELAKSANAAN
Tahun 1	2004
Tahun 2	2005
Tahun 3	2006

4. Bagi pelaksanaan program ini, pihak sekolah dan murid-murid adalah digalakkan membeli sendiri abakus dan buku yang berkaitan yang ada di pasaran. Buku yang dipilih bagi pengajaran dan pembelajaran program ini hendaklah yang mengikuti Huraian Sukatan Pelajaran terkini yang dikeluarkan oleh Kementerian Pendidikan.

5. Sila maklumkan kandungan surat pekeliling ikhtisas ini kepada pegawai yang bertanggungjawab di Jabatan Pendidikan Negeri, Pejabat Pendidikan Bahagian/Daerah dan Guru-Guru Besar di bawah pentadbiran Y.Bhg. Datuk/Dato'/Tuan.

"BERKHIDMAT UNTUK NEGARA"

DATUK ABDUL RAFIE BIN MAHAT
Ketua Pengarah Pendidikan Malaysia

s.k. 1. Y.B. Tan Sri Dato' Seri Musa bin Mohamad
Menteri Pendidikan Malaysia

2. Y.B. Dato' Abdul Aziz bin Shamsuddin
Timbalan Menteri Pendidikan Malaysia

3. Y.B. Dato' Hon Choon Kim
Timbalan Menteri Pendidikan Malaysia

4. Y.B. Dato' Mahadzir bin Mohd Khir
Setiausaha Parlimen, Kementerian Pendidikan

5. Ketua Setiausaha Kementerian Pendidikan

APPENDIX 2: Circular Issued by the Ministry of Education to make Abacus Compulsory in Primary School (Page 2)

6. Timbalan-Timbalan Ketua Setiausaha Kementerian Pendidikan
7. Timbalan-Timbalan Ketua Pengarah Pendidikan
8. Ketua-Ketua Bahagian Kementerian Pendidikan
9. Ketua Jemaah Nazir Sekolah, Kementerian Pendidikan
10. Pegawai Perhubungan Awam, Kementerian Pendidikan.

APPENDIX 3: Circular Issued by the Ministry of Education to make Abacus Compulsory in Primary School (Page 3)

Questionnaires (Children)

This survey is to find out what is the opinion of children on mathematics subject, abacus and mobile games.

Section A: Biography

Age : _____ years old

Gender : Male [ ] Female [ ]

Section B: Please tick (✓) accordingly based on the questions below

Do you or your parents have any Android device? (e.g. Samsung, Lenovo, Asus, etc) Yes [ ] No [ ]

Do you play games on your/parents mobile phones? Yes [ ] No [ ]

Have you played educational games before? Yes [ ] No [ ]

How often do you play the games?

< 3 times per week [ ] 3 to 5 times per week [ ] > 5 times per week [ ]

Section C: Please tick (✓) accordingly based on the scale described below

1=Strongly Disagree  **2=Disagree**  **3=Agree**  **4=Strongly Agree** 

Questions	1	2	3	4
I like Mathematics.				
I believe that Mathematics is an important subject.				
I enjoy the way teachers teach Mathematics.				
I like Abacus.				
I think learning to use Abacus is important.				
I use Abacus to calculate Mathematical problems.				
I enjoy the way teachers teach Abacus.				
Learning through games is fun.				
Learning Mathematics through games is fun.				
Learning Abacus through games is fun				

APPENDIX 4: Questionnaires forms for Children

Questionnaires (Parents)

This survey is to find out what is the opinion of parents on mathematics subject, abacus and mobile games.

Section A: Biography

Age : _____ years old

Occupation : _____

Gender : Male [ ] Female [ ]

Section B: Please tick (✓) accordingly based on the questions

Do you have any Android device? (e.g. Samsung, Lenovo, Asus, etc) :Yes [ ] No [ ]

If yes, do you let your child/children play with your Android Device? :Yes [ ] No [ ]

Do you ever download educational games? :Yes [ ] No [ ]

If Yes, please list the educational games that you had downloaded:

_____

Section C: Please tick (✓) accordingly based on the scale described below

Scale: 1=Strongly Disagree 2=Disagree 3=Agree 4=Strongly Agree

Questions	**1**	**2**	**3**	**4**
Mathematics is an important subject for the children.				
My child/children perform(s) well in Mathematics.				
My child/children like(s) Mathematics.				
Current Mathematics teaching methods are effective.				
Learning Abacus is important.				
Why do you think so? _____				
My child/children like(s) Abacus.				
My child/children perform(s) well in Abacus.				
Current Abacus teaching methods are effective				
Mobile game is a good way to teach children Abacus.				
Why do you think so? _____				
If there is a mobile game teaching children Abacus, I will download it.				

APPENDIX 5: Questionnaires forms for Parents

Name : _____ Score : _____

1) 3 + 2 =	2) 1 + 5 =	3) 8 + 9 =
4) 6 + 4 =	5) 3 + 9 =	6) 4 + 3 =
7) 7 + 1 =	8) 6 + 5 =	9) 3 + 6 =
10) 2 + 2 =		

Time Taken to Complete: _____

Printable Math Worksheets @ www.mathworksheets4kids.com

APPENDIX 6: Question Set for Testing

'FUN WITH ABACUS' MOBILE APPLICATION: USABILITY TESTING OBSERVATION CHECKLIST

This observation checklist is to record the reactions from the children when doing the usability testing so that it can be used to improve the functions and effectiveness of this application.

Section A: Biography

Age : _____ years old
Gender : Male [ ] Female [ ]

Section B: Please comment accordingly based on the questions below

Respondent's Expression	
	Comments
Facial Expression: (eg: Smile, Frown)	
Emotion: (eg: Happy, Sad)	
Seems interested	
Home Page & Menu Page	
Search the right button.	
Click the right button	
Face difficulties in searching button.	
Understand the menu page	
Tutorial Section	
Understand the instruction (Sound)	
Push the right beads	
Able to perform the correct calculation.	
Play Section	
Understand the questions	
Able to count and input the correct answer	
Able to cope in the games	
Speed in playing the game: (eg: Fast, Slow)	
Overall comments:	
_____ _____	

APPENDIX 7: Observation Checklist for Testing

'FUN WITH ABACUS' MOBILE APPLICATION: USER TESTING FEEDBACK FORM

The objectives of this feedback form is to record the feedback from the parents and teachers in order to improve the functions and effectiveness of the application

Section A: Biography

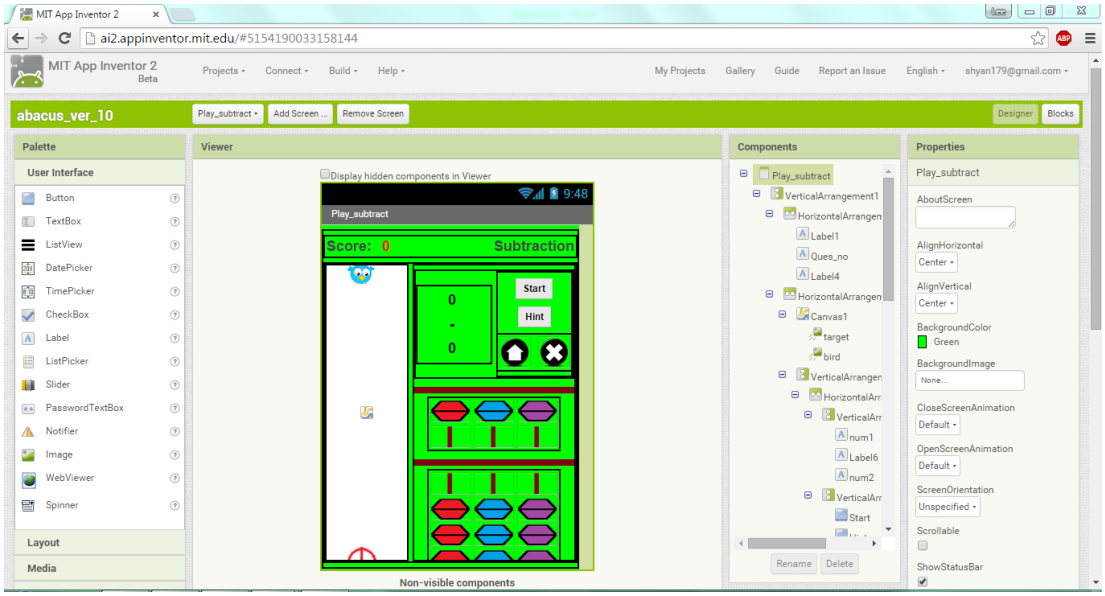
Age : _____ years old
Occupation : _____
Gender : Male [ ] Female [ ]

Section B: Please tick (✓) accordingly based on the scale described below

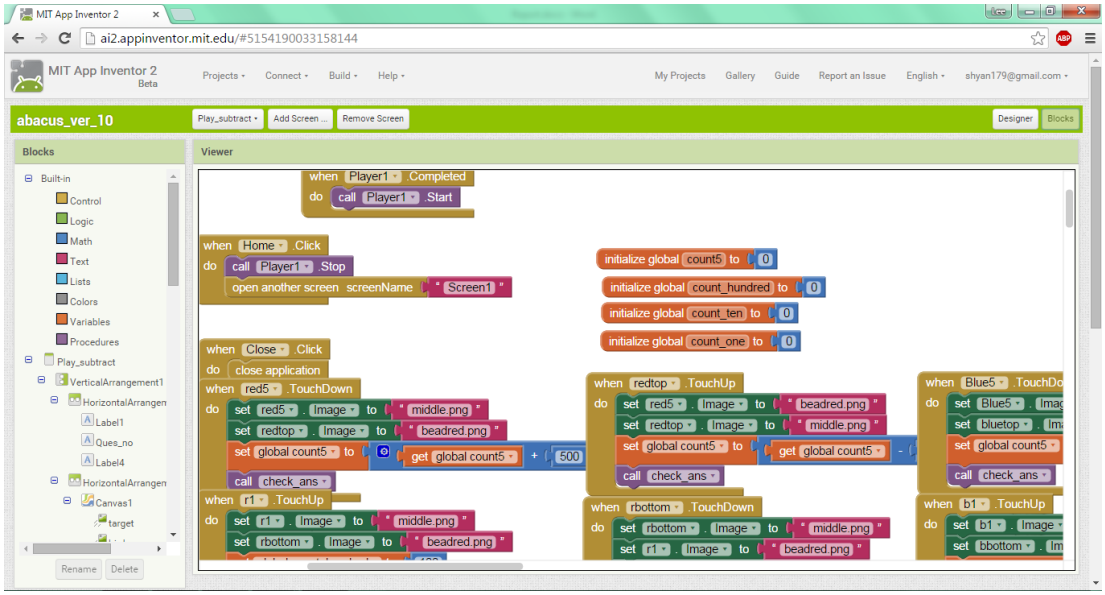
5=Strongly Agree 4=Agree 3=Neutral 2= Disagree 1= Strongly Disagree

	5	**4**	**3**	**2**	**1**
The application has user-friendly Graphical User Interface (GUI).					
It is easy to navigate through the application.					
The application is easy to use.					
The tutorial is easy to understand.					
The game is fun to play.					
The application is attractive, interactive and suitable for the primary school children.					
The application will help children to learn abacus.					
I am interest in using this application.					
I will recommend this application to the primary school children.					
Comments/ Feedbacks					
_____					

APPENDIX 8: Feedback form for Testing



APPENDIX 9: Example of Interface Blocks



APPENDIX 10: Example of Coding Blocks